NOVELTIES AT THE PARIS AUTOMOBILE SHOW.

By the Paris Correspondent of Scientific American.

THE "AUTO-MIXTE": A NEW GASOLINE-ELECTRIC MACHINE.

The "auto-mixte" is a new car in which an electric motor is used in connection with the gasoline motor for driving. It was designed by M. Henri Pieper, a Belgian inventor who is already well known for his work in the combination electric systems for automobiles. The new car is fitted with a four-cylinder motor which is connected direct with the differential on the rear axle. On the motor crankshaft is mounted the armature of a small dynamo whose field magnets are charged from a small storage battery which the car contains. This arrangement is superior to the ordinary electric automobile, as the distance the car can travel is not limited by the charge in the battery. At the same time, M. Pieper's arrangement has several positive advantages, one of which is that the dynamo can be made to run as a motor by current from the battery and thus to assist the gasoline motor and keep its speed about constant when going up grades and on hard places. Therefore a greater average speed may be maintained than can be had with a straight gasoline machine of equal power. The speed-changing mechanism is suppressed, which is a great gain. The spark, carbureter, and throttle levers are also dispensed with, as the latter are worked electrically, and the ignition point is fixed. Another advantage is the absence of any special starting device, as the electric
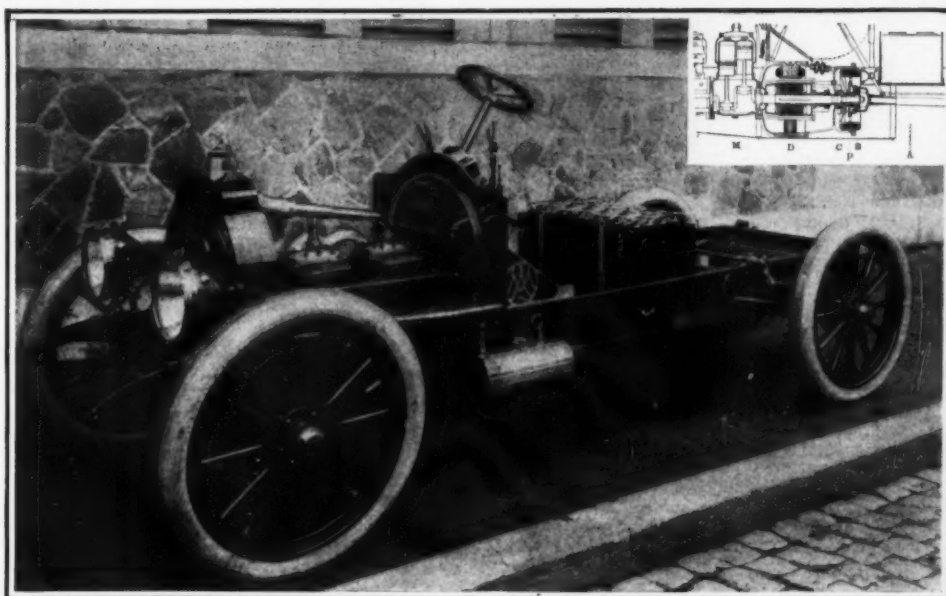
THE AUTO-MIXTE CAR.

charged by the dynamo, which acts as a generator during the periods where there is but a light load on the gasoline motor. On all ordinary roads, this form of automobile would seem to be ideal, as there is no speed change gear, the gasoline motor can always be started without cranking, and in case it breaks down, the car can be run a certain distance on the battery.
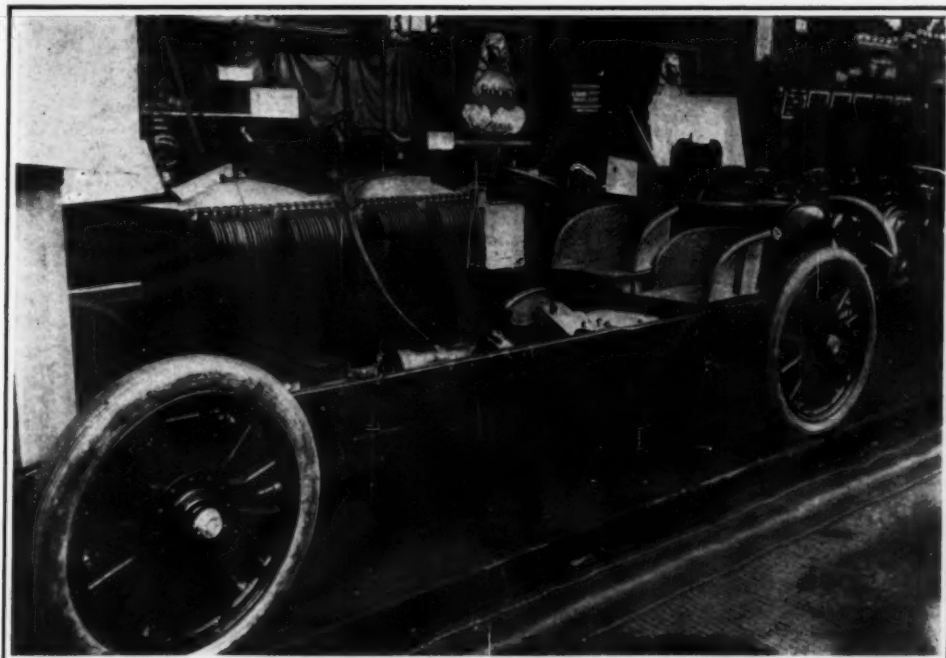
DUFAUX CAR.

Among the cars which attracted considerable attention at the show is the new Dufaux racing car, which proved to be one of the best of the year. It will be remembered that the Dufaux Brothers were to enter their cars to represent Switzerland in the Gordon-Bennett Cup Race, but owing to some difficulties with the Swiss Automobile Club the cars did not compete in that event. Since then the inventors have made a new departure in the design of the car, especially as regards the motor, and this gives it the somewhat unusual appearance which is seen in our engraving. The present construction of the motor has been adopted in order to make the car as light as possible and so bring it within the regulation weight of 1,000 kilogrammes (2,204 pounds) which is allowed in the standard heavy car class. In this way it was possible to put an addi-

THE BORDEREL SIX-WHEEL CAR.

motor will start the car, and the electric brake makes the usual brakes unnecessary. Furthermore, there is no magneto or special battery for the ignition current. As will be observed in the diagram, the construction of the "auto-mixte" is very simple. In the front of the car is a 4 x 4 four-cylinder gasoline motor of the usual form and fitted with mechanically-operated valves. The gas throttle is operated by a magnetic device which consists of an iron core working within a compound-wound solenoid. The latter opens the gas inlet to the motor to increase the speed should the electromotive force of the dynamo fall, and *vice versa*. The engine crankshaft carries just back of the dynamo a magnetic friction clutch consisting of the soft iron ring, C, which has two magnetizing coils sunk flush with the surface, and the iron disk, P, which is mounted opposite it and made to drive the propeller shaft through a slidable universal joint. When the current from the battery is sent through the coils, the attraction of the electro-magnet, C, for the disk, P, forms an easy and progressive clutch. The outer casing of the dynamo is extended farther in the rear, and on the other side of the disk, P, is mounted a second magnetic disk, B, which is fixed in the frame. When the loose disk is attracted against B, a very effective magnetic braking action is obtained which works in either direction. The storage battery, A, is placed under the driver's seat and is of special construction, furnished by the Tudor Company. It consists of 24 cells weighing 340 pounds in all. The outfit is completed by an electric controller device which contains all the circuits and by working a single lever it allows of starting up the motor, changing the speed, stopping, and reversing back. The storage battery of the car is kept

DUFAUX CAR.

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tional weight of material into the motor and the constructors are able to mount a motor which gives a very high capacity, ranging from 150 to 180 horse-power.

The weight is reduced by cutting down the water circulation system. The pump, etc., are suppressed and a new type of water-jacket construction is employed, which is somewhat unusual. The motor consists of four cylinders mounted in two pairs on the crank case. Each pair of cylinders is surrounded by a water reservoir of some size built of riveted sheet metal. This serves at the same time as a water jacket and a circulation chamber. The thermo-siphon principle of water circulation is used, and a system of radiating tubes is mounted on the tanks for the cooling. These are light copper tubes of small diameter which are curved about the side of the tank, entering it at the top and bottom. There are two sets of 75 tubes per tank on each side, making 600 tubes in all.

The cylinder diameter of the Dufaux motor is 9 inches, and the stroke 6.6 inches, while the mean speed is 1,100 revolutions per minute. At the races which were held during the month of November in the south of France from Arles to Salon, the new car was able to reach a speed of 1 kilometer in 23 seconds which is equivalent to 156 kilometers (103 miles an hour). This record was officially accepted at the recent meeting of the Automobile Club. The Swiss constructors are thus taking a prominent place, as it will be remembered that the Dufaux Brothers were among the first to build a motor-driven flying apparatus which would raise its own weight with a gasoline motor, and that they are also known for their "Moto-sacoche," or block-motor apparatus, which fits into the frame of a bicycle. These two devices have already been described.
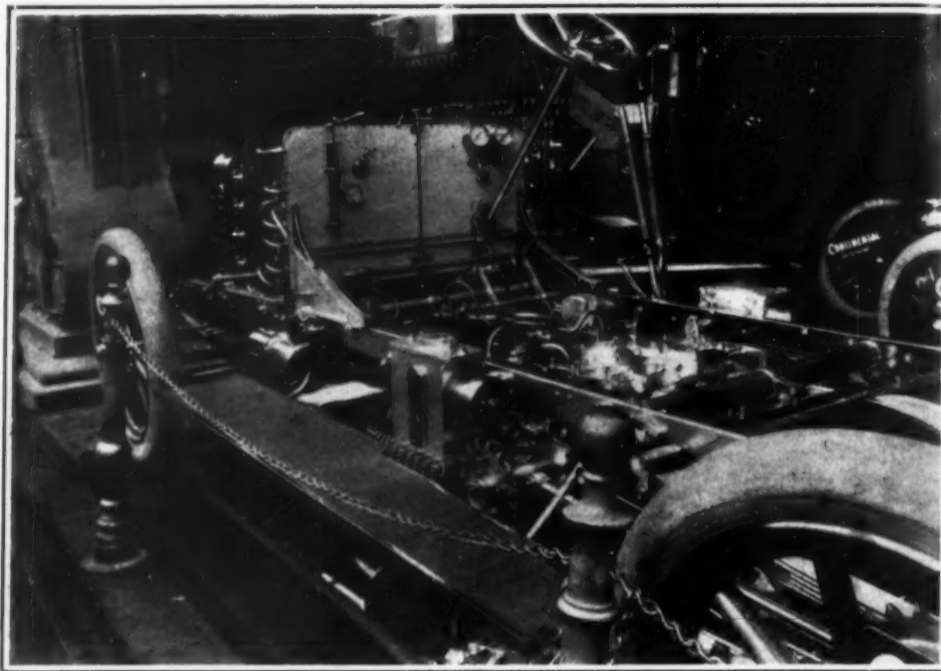
STEAM AUTOMOBILE.

The new Weyher and Richemond steam automobile has attracted considerable attention at the recent Paris show. It is the invention of two Austrian engineers, Messrs. Friedmann and Knoller. A small steam pump is made to work the water and oil feed. The water pump takes water from a tank placed at the rear of the chassis and sends it into the flash-tube boiler which is mounted just behind the front axle. The oil pump receives a supply from a tank at the back and feeds it to the burners under the boiler. The heat of the oil-burner causes superheated steam to be generated instantaneously in the boiler tubes. The steam passes through a pedal-operated throttle valve to the motor, which is placed near the middle of the chassis, with the feed-pump placed in front of it. The motor drives the rear wheels through a differential countershaft and two chains. The exhaust steam from the motor goes to a condenser which takes the place of the ordinary radiating coils at the front of the car, and the condensed water returns to the reservoir. The quantity of water and petroleum fed, for the boiler is determined by the speed of the steam pump, and the latter is operated by a steam cut-off valve controlled by a handle in the steering wheel of the car.

The flash-tube boiler is formed by a set of steel tubes and is contained in a sheet-iron box the lower part of which is lined with refractory material and serves as the combustion chamber. At the top, the flue is reversed and brought along the side of the box so that the fumes escape below the car. One of the main points of the Weyher and Richemond car is the form of oil-burner which has been adopted. It has been the object of the inventors' researches during several

FOUR-CYLINDER, POPPET-VALVE MOTOR OF THE WEYHER-RICHEMOND STEAM CAR.

NOVELTIES AT THE PARIS AUTOMOBILE SHOW.

years. Ordinary kerosene is used in it, and the burner is easy to handle. The oil from the feed-pump goes through a vaporizing worm-tube placed above the burner. It is transformed to high-pressure gas which escapes from a Bunsen burner of special form giving the proper air-supply. Owing to the design of the burner the quantity of air is that which gives a perfect combustion of the gaseous mixture. The force of the jet prevents it from being affected by the air rush from

the car, and the products of combustion, which are without smoke or odor, escape below the car. Before the gas jet is placed a conical piece for giving the proper divergence and the flame is thus properly directed against the boiler tubes. During the stops of the car when the main burner is not running, a small extra burner keeps the whole at a moderate temperature.

The car motor is of the horizontal four-cylinder type

CHASSIS OF THE WEYHER-RICHEMOND STEAM CAR.

having cam-operated poppet valves. It is entirely inclosed in a case which is joined to the differential case. The pistons of the four parallel cylinders work a common crankshaft in the middle of which is a straight gear which works the differential countershaft lying parallel to the former. The differential countershaft has sprockets at each end. A lever on the side of the car allows of displacing the cams of the motor so as to control the speed and also to reverse the motor. To start the car the throttle-valve foot-pedal is pressed slightly when steam is sent to the motor and the car starts at once. By raising the foot, the car is stopped.

DELAHAYE BOAT MOTOR.

The Delahaye Company, of Paris, besides exhibiting a number of their standard cars, showed a newly-designed motor known as the "Titan" for use upon a gasoline launch. The motor is of the upright pattern and has been mounted on the large racing yacht, the "Dubonnet," having a capacity of 300 horse-power. This boat is capable of an unusually high speed. During the last racing events at Monaco it made a brilliant performance and captured the cup which was offered by the Prince of Monaco. Later on, during the races which were held on the Seine at Juvisy in the neighborhood of Paris, it made very high speed, this being no less than 34 miles an hour. The new Titan motor is of the four-cycle type. It has four cylinders, mounted separately upon an aluminium crank-case. An especially noteworthy peculiarity of this engine is that it is fitted with multiple valves in the cylinder-

heads. Instead of a single large valve, experience has shown it is better to use a number of smaller valves, and this arrangement works very well in practice. On the present motor there are three valves on each cylinder for the inlet and the same number for the exhaust, making six valves in all per cylinder, or 24 for the whole motor.
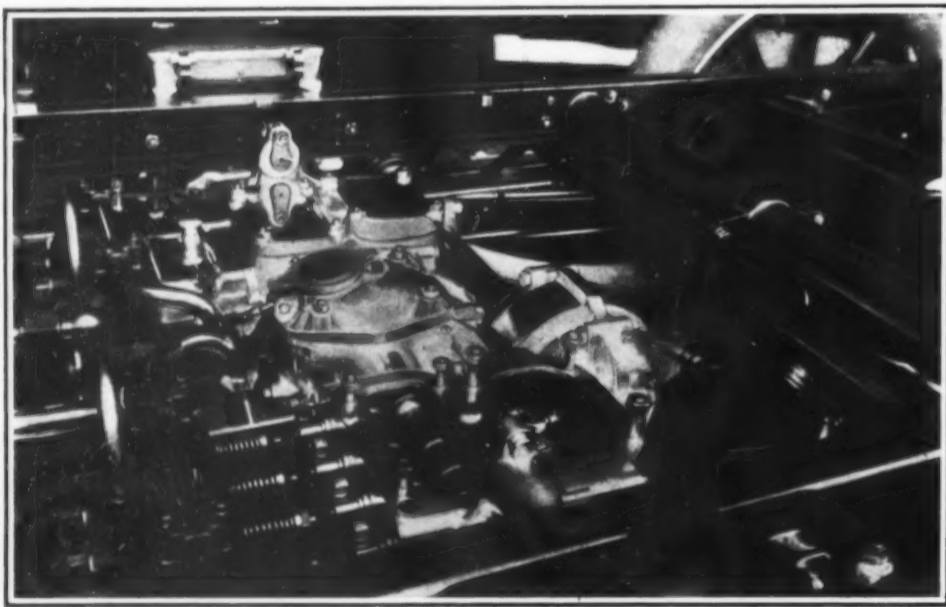
Both inlet and exhaust valves are in the tops of the cylinders and are operated from a single camshaft above them. The ignition current is furnished by an improved form of magneto as well as by accumulators. In order to cut down weight as much as possible, all the steel shafts and like parts of the motor have been made hollow where this could be done. This method is coming into use upon a number of marine motors which have appeared lately. A foundation frame of light steel is used here, and when placed in the boat the reverse mechanism is mounted between the motor and the propeller. In order to start the motor, it is brought to the compression point and the current turned on, when it starts easily. An average speed of 700 or 800 revolutions per minute is obtained. The cylinder bore and stroke are 12 inches. Water-jackets of sheet copper are used on the cylinders and the latter are turned off inside and out. On the left of the motor is seen a short half-speed shaft driven by spur gears from the crankshaft. This shaft is coupled direct to the gear water pump, and it also drives through bevel gears the vertical shaft that in turn drives the camshaft above the cylinders. This motor is probably the largest four-cylinder engine for marine work that has thus far been constructed.

A POWERFUL NEW SEARCHLIGHT.

Among the novelties exhibited at the last Paris automobile show was a new searchlight which is unusually powerful and which makes use of an oxy-hydrogen burner. This searchlight was designed by the well-known Bleriot firm, which has had a great deal of experience in the construction of acetylene and other projectors. Having brought the acetylene lamp up to the highest possible power, it was desired to find a light which would go much higher than this and light up the road for a great distance in front of the car, thus rendering a night trip comparatively safe and allowing a higher speed to be used.

After a long series of experiments the designers found a light which is no doubt as powerful as the arc lamp or oxy-hydrogen burner and which is at the same time of very compact form so as to be easily carried on the car. It is also very simple in its operation. The principle of the new lamp consists in the use of a jet of vaporized gasoline and a second jet of oxygen which is fed from bottles of compressed gas. As in the oxy-hydrogen lamp, the two jets are made to play upon a lozenge of prepared oxides. The new system can be fitted to any of the usual forms of searchlight, and the Bleriot company has applied it to its standard types with parabolic mirror and lens, besides using it with the specially designed projector which we illustrate. At the back is a Mangin mirror of the marine type, of high power, and in front is a plane glass. On each side of the projector is a small gasoline reservoir. The two are connected by a tube, and are filled at the same time. They contain sufficient fuel to maintain the light for 20 hours. In the inside of the apparatus, and replacing the acetylene burner, is placed a small device made of copper or bronze. This forms the burner and serves to hold the piece of oxide which is in the form of a lozenge. Attached to it are the tubes which bring the vaporized gasoline and the oxygen. The burner will be noticed already mounted inside the lamp, while a second burner is seen below. The lozenge is made of compressed oxides of the rare earths mixed in the most suitable proportions for withstanding the highest temperatures without cracking.

It is extremely compact, and is said to resist perfectly all the shocks it is subjected to in an automobile searchlight. The makers claim that it will last indefinitely. The oxygen is contained in the steel flasks which are now to be found in common use and can be employed with confidence. The desired pressure of the gas is regulated once for all by a special form of expansion valve. A pressure gage shows at all times how much gas remains in the tube. Two flasks, together with the proper reducing valves and piping, are all arranged in very compact form in oak boxes which can easily be stowed in the car. Each bottle contains enough gas to last 12 or 14 hours. When a flask is exhausted, a fresh one can be readily inserted. In France the Bleriot firm has adopted a system of depots throughout the country for the gas flasks. This was arranged in connection with the Oxyhydric Company. The list of depots is on each bottle, for the convenience of tourists. Besides this, it is now comparatively easy to obtain the oxygen flasks, owing to their extensive medical and industrial use, and also to the fact that the 13-pound tubes can be sent by parcel post.
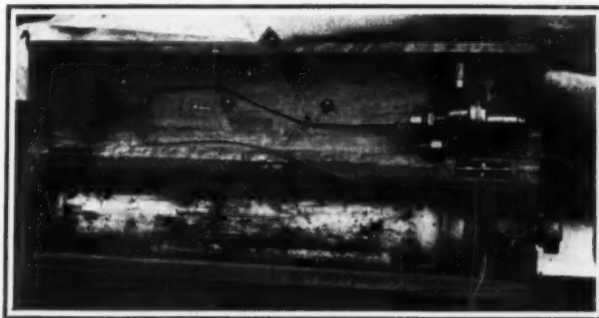
The operation of starting the burner is very simple. After the gasoline reservoirs have been charged, the burner is heated up by a special flame heater such as is commonly used for gasoline or alcohol furnaces, and at the end of a minute the vaporized gas forms a flame. The oxygen flask is then opened by unscrewing the plug outside of the containing box. The lozenge at once becomes incandescent and rises to a white

heat after the gasoline supply has been regulated by turning by means of the milled porcelain valve disk which will be noticed at the front of the burner inside the lamp. An extremely powerful and dazzling light is thus obtained, and the beam reflected from the mirror shows the road for several hundred feet ahead. To extinguish the light, the gasoline and oxygen valves should be closed.

The new light is simple, safe, and odorless, and needs no cleaning. It employs the same grade of gasoline as is used in the motor. The light is said to be 28 times that of acetylene, and with a medium type of projector a newspaper can be read at 3,000 feet distance. There is no doubt that it will be of great service for automobiles or yachts.

THE WINTER SLEEP OF ANIMALS.

In the strict definition of the word there are very few mammals in Maine which hibernate, becoming so lost in sleep as to be oblivious of what is going on around them, says the Bangor News. Our raccoons and skunks and bears crawl away to hiding places and seem to be torpid, though they awaken and become active as soon as their apartments are invaded by human foes.

Twice we have seen bears uncovered from under fallen trees during very cold weather in midwinter, and in both cases the animals were awake and on the defensive as soon as the choppers could get at them. Raccoons do not hibernate in the sense of becoming unconscious. They den up in hollow trees and logs, but let some one come along and strike forcibly above their secluded dens, and they are up and dressed and ready to flee as quickly as a family is when the fire alarm is sounded at the front door. During nearly every winter thaw, bears, skunks and raccoons come out and walk about on the snow, at times going miles away from their winter quarters.

Our greedy little friend, the chipmunk, is not believed to sleep any more hours in the winter than in the summer. It puts by a plentiful store of food and performs light housekeeping in its hole far below the frost. So far as any one can learn the chipmunk dwells alone in its underground den. The old notion that the father and mother chipmunk took their children into

winter quarters and gave them lessons in stealing **grain and gnawing holes in corn bins is a fabrication.**

We have talked with scores of men who have been close observers of chipmunks for years, and as yet we have found none who ever saw two chipmunks dwelling in the same compartment. Skunks, however, are

COMPRESSED HYDROGEN CYLINDER FOR USE WITH BLERIOT LAMP.

very social in their winter habits. One winter when a barn in Waldo County burned down the charred bodies of eight skunks were taken from the ashes and rubbish left from the blaze. Raccoons have small objections to receiving sleeping partners in hollow trees, though bears seem to be morose and solitary brutes, which have no liking for their kind.

But the woodchuck sleeps soundly enough to make

300-HORSE-POWER, FOUR-CYLINDER, DELAHAYE BOAT MOTOR.
Bore and stroke, 12 inches.   Speed, 700 to 800 R. P. M.

up for all the wakeful and half-wakeful creatures. Boys who have stored tame woodchucks in barrels in the cellar to pass the winter have taken the torpid animals and carried them miles in their arms without breaking in upon their sleep. A fat woodchuck in early winter may be brought from its nest and placed by the

side of a warm stove for a period of half an hour without making any apparent change in its conduct.

But when a slumbering woodchuck is warmed and rubbed until it is fully awake it is about the most disagreeable beast living. Though it has been as tame as a pet kitten when put away, it will "snicker" and gnash its teeth and show many signs of displeasure if aroused from its long sleep before it has burned up its surplus fat by respiration.
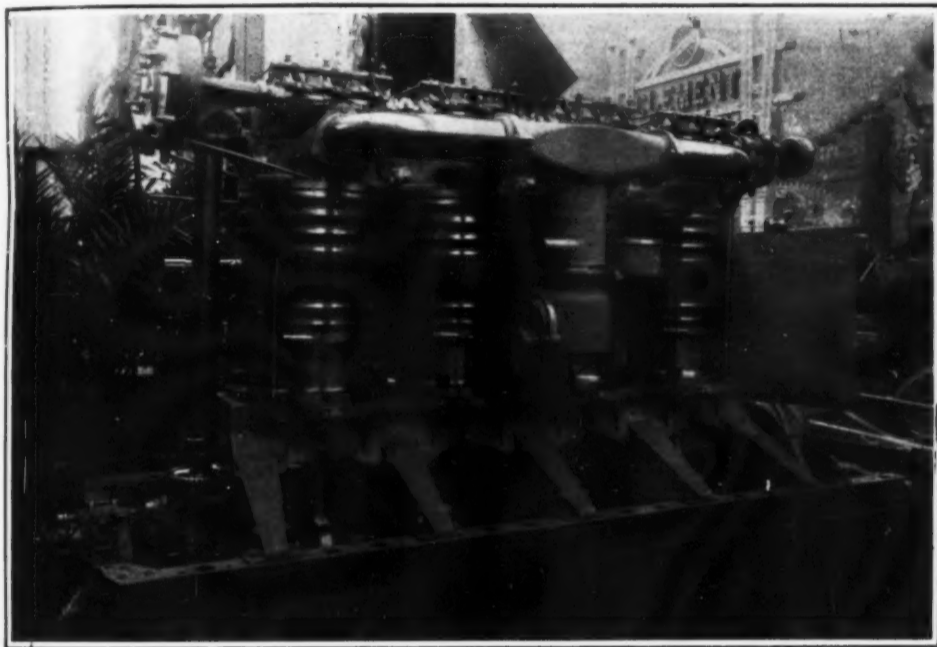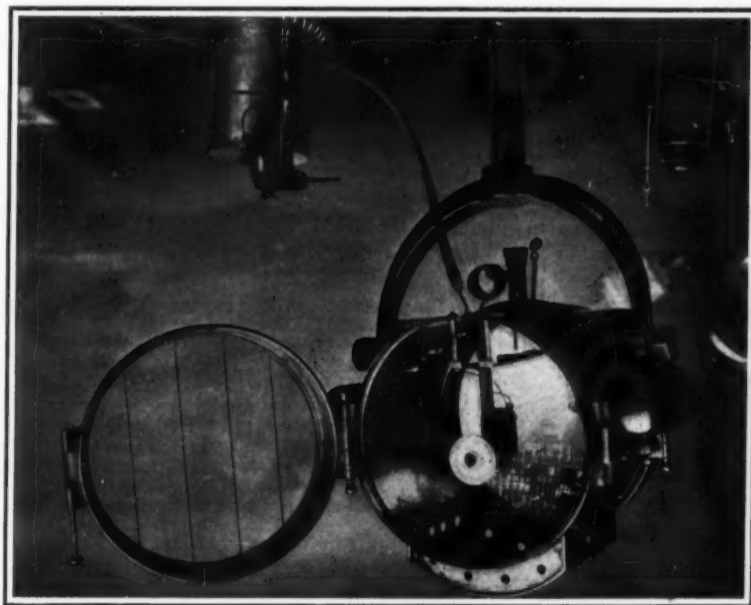
It requires long hunting and much patience to find a slumbering bat in midwinter. The animals are so small they can hide in almost any crevice, and their color is so subdued that unless one is looking for them he can never find them. The general impression is that bats hibernate from October until April, as no one sees them flying about during the cold months.

Years ago we found a seemingly torpid bat concealed among a wad of hay in the mortise of a beam in a hay barn. The season was winter, for we remember there was snow on the ground. It was cold weather, too, for we took off a thick woolen mitten as a cage for holding the bat until we carried it to the house and installed it as a pet. The reason why we never tamed and studied the habits of that particular bat was because the pestiferous little creature bit us sharply in the thumb as soon as we touched its body, and before we were over our great surprise at this impertinent act the bat had fled from sight. It may be that bats assume a sleep that leads to unconsciousness in winter, though the one we met assumed nothing.

Nearly all reptiles—including frogs, toads, snakes and turtles—bury themselves below frost in winter and remain sluggish and at times torpid until spring. If a frog is dug from the mud and placed in a spring it will swim away, though slowly at first.

The little newts or salamanders and the lizards, we are unable to say concerning their habits. They are reptiles, though the specimens found here at the North are small enough to be classed as insects. We have dug both salamanders and lizards from springs in winter and have found them in full possession of their faculties. We have left newts out of doors in water in a tin pail over night and had them freeze as solid as ice, though when they thawed out they did not show any ill effects from frost bites.

Frogs and toads can stand freezing and thawing a few times, though the experience seems to be "wearing," as most of them succumb after repeated trials. Just how snakes pass the winter we do not know. Two or three specimens of the common striped snake which we have dug from stone heaps in the winter appeared

THE BLERIOT OXYHYDROGEN SEARCHLIGHT.
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to be frozen and stiff, though a natural repugnance to the reptiles prevented close observation.

Most insects can undergo freezing and thawing with impunity. Insects which breathe air and dwell on land cannot survive freezing in water, though dry cold does not impair their health.

ARMORED CONCRETE.—PART III.*

By Lieut. Henry J. Jones, A.O.D., A.R.C.Sc. (Lond.), Inspector of Ordnance Machinery.

Three distinct methods are adopted for the erection of work in armored concrete. Some contractors build the whole of the work in suitable pieces, in sheds adjacent to the site, or at a central workshop from which
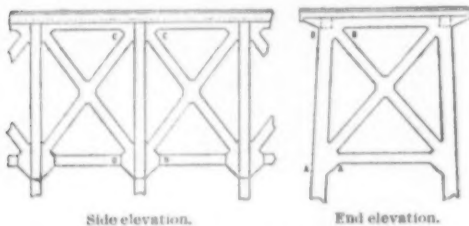

Side elevation.　　End elevation.

FIG. 1.—DESIGN FOR PIER, IN ARMORED CONCRETE.

they are sent to the place required when ready for erection. In this way large quantities of columns, piles, beams, floor slabs, etc., are kept in stock, and are available for immediate dispatch. Others erect an elaborate timber falsework in situ, on which the green concrete is tipped and rammed into close contact with the armoring, which is laid according to the design as the work proceeds. This plan makes first-class carpentry a necessity, and also requires a costly system of shoring to keep the falsework up to its intended position when the concrete is laid and rammed. A third method is to erect the armoring first, and then to build the concrete round it, suitable molds being used, partly supported by the existing armoring. The system adopted will depend to a great extent on the nature and architectural elaboration of the finished work. For warehouses and factories, where many similar columns, piles, floor slabs, beams, etc., are required, the first sys-
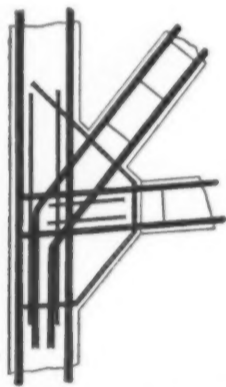

FIG. 2.—DISPOSITION OF ARMORING AT AA, FIG. 1.

tem has an obvious advantage from an economical point of view; whereas for bridge work, the second, or a combination of the second and third systems, is the only one possible. In the construction of tunnels, pipes and sewers, the system adopted will depend upon the magnitude of the work, and the conditions under which it will have to be carried out: as a rule the third system would be adopted.

FLOORS, SLABS AND ROOFS.

The system of construction for floors, slabs, and roofs is determined by the extent of the work and the nature of the loads to be carried. If intended for small buildings and offices, the items can be made before erection; but in the case of warehouses, factories, piers, and jetties, where live loads and vibratory stresses have to be borne, a monolithic structure should be secured by building in molds directly on the site. For the

FIG. 3.—DISPOSITION OF ARMORING AT BB, FIG. 1.

lighter classes of monolithic structure, expanded metal is admirably suitable; it is also much used for the roofs of reservoirs, and for thin partition walls. The meshing is simply laid over the ribs or floor beams, which have been already erected, and the green concrete is applied to the required thickness, being supported from below by suitable supporting work, which is removed as soon as the concrete has set. In cold

* Technics.

storage factories, the floor beams and ceilings are invariably erected first, the floor being laid afterward. The ceiling is then solid with the floor beams on their under side, and the floor is solid with them on their upper side, the air space between being a great aid to the maintenance of a low temperature for refrigeration.

When laying floors, care should be taken to prevent the upper layers of green concrete setting too quickly, particularly if the climatic conditions are such as to favor a rapid drying of the surface of the concrete. If precautions are not taken, unsightly cracks will result, which will afterward have to be filled with cement. A good plan is to damp the surface of the concrete every three or four hours, for three days after concreting, and to cover the surface with canvas covers or tarpaulins. Floors are finished when necessary by setting beveled sleepers in the soft concrete, and then nailing the floor boards to the sleepers. The sleepers are spaced at about two feet centers. Factories and warehouses usually have their floors finished by a layer of cement mortar, using one of cement to two of sand. This finish should be applied while the concrete is fresh and soft; but when this is not possible, the concrete should be scraped, guttered, and washed with water before the mortar is spread. Granite chippings small enough to pass a ¾-inch gage are often added to the mortar to form the finish for the corridors of public buildings. For reservoir floors and walls, the concrete is guttered by horizontal grooves about ½-inch deep and ⅜-inch wide, the gutters being spaced at about 6-inch centers; the concrete has then two layers of asphalt applied to it, each layer being about ¾-inch thick, the grooves preventing the asphalt creeping or slipping over the concrete.

Roofs are made practically in the same manner as floors, but are usually much lighter. Floors should never be reduced below 4 inches in thickness, to avoid cracking; on the other hand, roofs are often only 2 inches in thickness if the armoring is of the expanded metal type, or expansion arising from changes of temperature is provided for by placing the armoring in both directions—in length and breadth. Roofs can advantageously be covered with a 1-inch layer of asphalt to insure water-tightness.

In the Monier floors the armoring consists of round rods varying from ¼ inch to ⅝ inch diameter. The rods are spaced at about six times their diameter, and are crossed at right angles, being connected by iron wire bound round them. This artificial method of securing the rods takes considerable time, and is thus a somewhat costly process. To produce continuity of metal, the different lengths of rods are overlapped for about 8 to 16 inches, and bound with wire. The weight w of a floor in pounds per foot super, when built on this or the Hennebique system, may be taken to be given by the relation

$$w = 12\,t + 15,$$

where t is the thickness of the floor in inches.

TABLE I.—PARTICULARS OF SLABS CONSTRUCTED ON MONIER SYSTEM.

Span in feet.	Depth in inches.	Diameter of longitudinal rods in inches.	Diameter of transverse rods in inches.
3	2·0	⅜	⅛
4	2·5	7/16	⅛
5	3·0	11/16	3/16
6	4·0	11/16	3/16
7	4·5	7/16	3/16
8	5·0	7/16	¼
9	6·0	¼	¼
10	6·5	¼	¼
11	7·0	5/16	¼
12	7·5	11/16	5/16
13	8·5	⅜	5/16
14	10·0	⅜	5/16
15	11·0	⅜	5/16
16	12·0	⅜	5/16

Table I. gives particulars of slabs constructed on the Monier system, designed to carry 1½ hundredweights per foot super above the dead load of the floor itself. The armoring is spaced at about 3-inch centers.

When floors are continuous over the supporting walls or columns, tensile stresses are set up on the upper side, and armoring has to be suitably placed to take these tensile stresses. The safe load for floors on the Hennebique system is proportional to the square of the thickness of the floor, the percentage of armoring being invariably over 2 or 3 per cent. Table II. gives the live loads in pounds per foot super, which Hennebique floors can carry for different spans.

The thickness of the floor may, however, be advantageously increased, and the percentage of armoring decreased, from the values given in the above table.

The Schlüter are similar to the Monier floors, but the rods are crossed diagonally, and the longitudinal rods are of the same size as the transverse ones. The Cottancin floors have their rods interlaced like the canes of a chair seat or a basket, and the Hyatt floors have square rods with holes through which small transverse rods pass. Over fifty systems of armoring are in use, and in most cases the only points of difference are the shape of the section and the method of attachment and adjustment. The floors may be calculated from the formula—

$$72\,b\,t^2 = M;$$

t being the thickness of the floor in inches, b the span in feet, and M the maximum bending moment in pound-feet. The floors calculated by the above formula have 2½ per cent of armoring, and are supposed to be merely resting on supports at the two sides of the span. If the floor is supported on four sides, the thickness will be 0.7 t calculated from the above formula; and if the
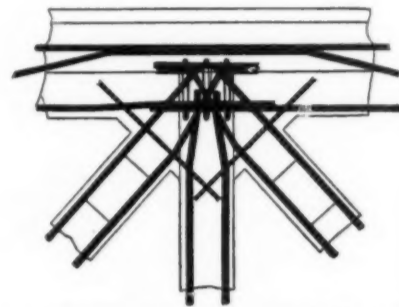

FIG. 4.—DISPOSITION OF ARMORING AT CC, FIG. 1.

floor is continuous over the four supports, the thickness will be 0.6 t.

BEAMS.

It is obvious that, as the span increases, a limit will soon be reached beyond which it is not economical to use plain floor slabs, for their dead weight becomes of such magnitude as to prohibit their use. We have thus to resort to a division of the main span by cross beams resting on columns, and the floor is laid on these beams, which are arranged to take as much of the load as to render it possible to reduce the thickness of the floor within reasonable limits. Armored concrete beams are typical of the type of construction in which the merits of two component materials are made to serve a common end; but in the particular case of steel and concrete, the actual part played by the steel is not at all well understood. With columns and foundations in armored concrete the work is either so stiff or massive that the tensile stresses induced by lateral or eccentric loading in the one case, or by uneven settlement in the other, are of very small magnitude compared with
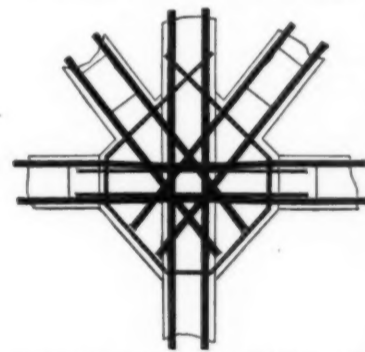

FIG. 5.—DISPOSITION OF ARMORING AT DD, FIG. 1.

the compressive stresses induced by the dead load; thus the tensile stresses are amply met by the armoring, or it may be, are greatly met by the concrete itself. On the other hand, with beams, floors, arches, and pipes under internal pressure, the tensile stresses may be of such a magnitude as to work both the steel and the concrete to their safe limits, and thus it is to these examples of construction we must turn to get a just illustration of the practice and theory of armored concrete. The need for any sort of reinforcement exists, owing to the liability of the concrete to fail under tensile stress. When, however, the tensile stresses are almost negligible, it is obvious that the use of the armoring will be somewhat obscure. We select the

TABLE II.—LIVE LOADS, IN POUNDS PER FOOT SUPER. FOR HENNEBIQUE FLOORS OF DIFFERENT SPANS.

Thickness of floor in inches.	Span in feet.											
	5	6	7	8	9	10	11	12	13	14	15	16
3·0	450	300	200	140								
3·5	600	400	280	200	140							
4·0		560	390	280	200	160	120	90				
4·5		690	500	370	270	210	160	130	100	70		
5·0			640	470	360	270	200	150	120	100	80	60
5·5			670	500	390	290	230	190	150	130	100	80
6·0				690	530	410	300	210	170	140	130	100

beam as being the most familiar example for illustration.

Speaking generally, beams do not differ in constructional details from floors. The same armoring is used in both, the only difference being, that as beams are usually deeper than floors, the shearing stresses become more pronounced, and greater provision has to be made for them by a liberal use of stirrups or vertical binding rods. In some systems the armoring consists entirely of straight rods, disposed in any part of the beam where tensile stresses are likely to be called into play. In others, specially bent rods are joined or welded to straight rods, and when welding has to be done it would appear that wrought iron is more suitable than steel. Fig. 1 shows the side and end elevation of a pier in armored concrete; the disposition of the armoring in the beams, piles and cross-beams, is shown in Figs. 2, 3, 4 and 5. Fig. 2 illustrates how beams are connected and secured to the piles, and the use of straight and bent rods in the armoring. Figs. 3 and 4 show how the stirrups are employed where the shearing stresses are most intense. The beams and piles gave, on the average, about 3 per cent of armoring, the diameter of the rods varying from 1 inch down to ⅝-inch diameter, the stirrups being made to suit the depth of the beams. Four rods were used in each beam and pile, but in some very heavy work as many as twenty-four rods have been used.

It is usual to arrange the dimensions of the beams so that the whole of the compressive stresses are taken by that portion of the concrete on one side of the neutral axis; but in some cases, as with continuous beams or heavy beams of small depth, a proportion of the armoring is distributed along the compressed portion of the beam, the steel rods either taking up the excess of compressive stress over that at which the concrete can be safely worked, or else taking up the tensile stresses at the places where they occur over the supports. As a general rule we may take it that the economical depth for an armored concrete beam, freely supported at both ends, is one-twentieth the span, and is thus approximately the same as that of a steel girder of equal strength. Armored concrete beams are now made for spans up to 100 feet for buildings, and 150 feet for bridges. But for each class of work beyond this limit, the weight becomes excessive. Several arched ribs for much greater spans have, however, been successfully built.

The beams are made in much the same way as piles and columns: they can be made in sheds on the site, or in the actual position they are to occupy when finished. The green concrete is tipped into molds made of a 2-inch bottom plate, carrying by clamps or screws, and two 2-inch side plates. When being made in their final position, the molds are shored from below every five feet, and the shoring is not removed until at least three or four weeks after the concrete has been laid. As before stated, the ceiling and beams are erected

first, the floor being afterward worked on the top of the beams. We thus obtain a very perfect monolithic structure in which any vibration set up by machinery, falling loads, etc., will be of much less extent than with an ordinary type of building, in which there is often a great want of rigidity, the beams and arches being loosely connected and able to vibrate independently of other parts of the structure.

Experiments have shown that whereas ordinary concrete columns will crack when a load is carried which causes an extension per unit length of 1/10,000, columns armored with a suitable percentage of steel are able to give ten times this extension without showing any signs of fracture. The explanation of this important fact is to be found in this, that unarmored concrete is heterogeneous in structure, and any extension which takes place will be almost wholly confined to weak sections which are certain to exist, however much care be taken in the mixing and ramming of the materials. Thus, since the strength of concrete in tension is determined by the tensile strength of the matrix, which is low, we must expect fracture to occur at a comparatively low stress. The effect of the armoring would appear to consist in rendering possible a more even distribution of the stress over the weak sections, in giving a more uniform extension to the column, and in taking up the whole of the tension at points where the matrix has been worked beyond its yield point. This fact is particularly interesting in the case of beams. Simple concrete beams invariably fail on the tensile side, by diagonal cracks arising from the combined action of the tensile and shearing stresses; and this failure occurs long before the compressed portions of the beam have been worked to their safe limit, the maximum deflection being very small. With concrete beams having a suitable percentage of properly disposed armoring, quite new elastic properties are realized, and the beam can be loaded to give ten times its former deflection without visible sign of fracture by cracking on the tensile side. The permanent set with armored beams is also much less than that with plain beams. The reason of this increased range of elastic properties will become clear when considering the theory of armored concrete beams.

(To be continued.)

THE GAS TURBINE.[*]

IT was but natural that the rapid evolution and success of the steam turbine, occurring at practically the same time as the development of the internal-combustion engine, should lead to the question: "Why not a gas turbine?" The solution of this problem is occupying the attention and time of scientists and inventors the world over, but as yet the successful gas turbine is a thing of the future.

In approaching the problem, two general methods of treatment present themselves: First, the dry-gas turbine; second the turbine in which the products of controlled combustion are mixed with steam. Again, under each method, two cycles of the working fluid are possible: The standard Otto or explosive cycle, and the Joule or constant-pressure cycle.

It is not the intention to present the advantages of the turbine over the reciprocating engine, or to discuss the relative merits of dry and wet-gas turbines, or the Otto and Joule cycles; this has been done time and time again by high authorities, who have presented their opinions in the technical press. It is conceded that the turbine offers many advantages over the reciprocating engine, and that the gas turbine offers peculiar ones which are attainable in no other type of heat motor. Theoretically the gas turbine offers just as good a thermodynamic efficiency as the piston-engine, yet constructive difficulties have operated to prevent its successful realization. The principal difficulties are three in number, viz.:

1. The apparent necessity of working with such high initial temperatures that no known constructional material could long withstand their action.
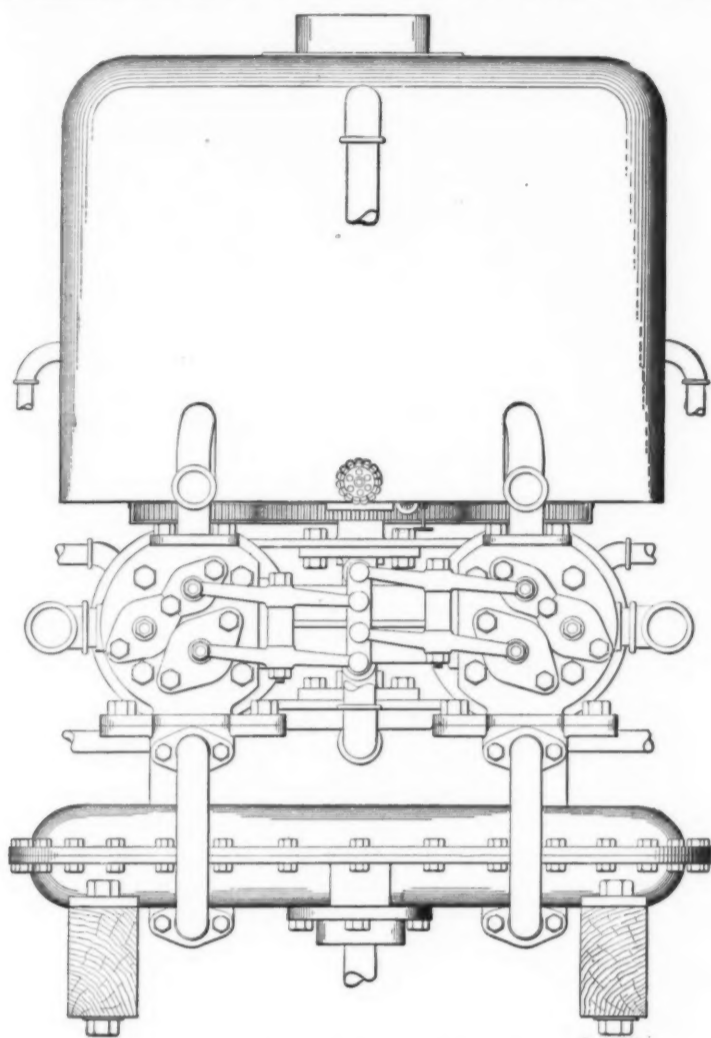
2. The high rotative speed demanded in order to

FIG. 1.—THE GAS TURBINE.

FIG. 2.—THE GAS TURBINE.

[*] Reprinted from Power.
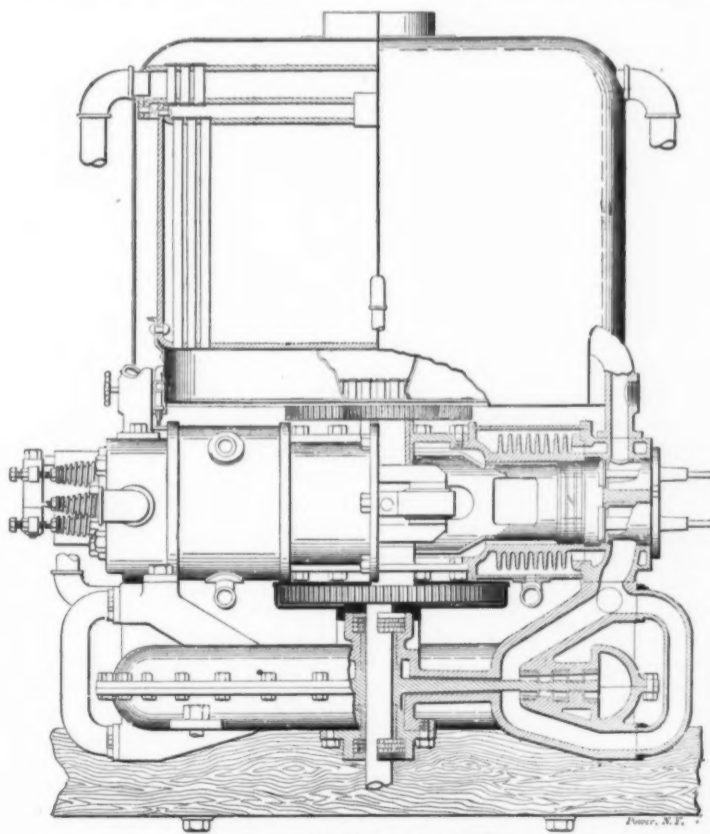
realize good efficiency, thus creating stresses far beyond the limit of the ordinary materials. This difficulty is found in the steam turbine, although the dry-gas turbine would demand a still greater peripheral velocity.

3. The difficulty of compressing the elements of combustion to the high pressures of the turbine and burning them under this pressure.

It is believed that the wet-gas turbine offers a solution to the first two difficulties, and that the only impediment to its successful realization is the last difficulty mentioned. As to the first difficulty, suppose that into the hot products of combustion there is injected a suitable quantity of water. The thermodynamic principles involved would be that of the steam boiler and furnace, except that in the boiler the flame is only under atmospheric pressure and is not in actual contact with the water, while in the turbine combustion chamber the flame exists under the same pressure as the steam and transmits its heat by actual contact. The resultant product is, in the one case, pure steam; in the other, a mixture of steam with nitrogen and carbonic acid gas. In any case, the result is an exchange of small heat-mass at high temperature for greater heat-mass at low temperature.

The theoretic efficiency will be somewhat decreased, but not in anything like the proportion in which the temperature decreases. Again, the specific gravity of the mixture is greater than that of the dry gases themselves, in which case in the conversion of the heat energy of the gases into kinetic energy, the resultant velocity is considerably decreased, thus presenting a solution to the second difficulty.

Suppose we employ for the compression as well as for the combustion chambers, the cylinders of a four-cylinder gas engine, working on the standard Otto cycle. This engine is mounted in the casing of a turbine, to which it is geared with the proper velocity ratio of gear wheels, Figs. 1 and 2. The turbine should be of the radial-expansion type in order to reduce its axial length. Above the engine is located a small boiler of the automobile type, provided with a burner for utilizing petroleum or crude oil and capable of supplying the turbine below at full load. The cylinders of the gas engine are water-jacketed, the discharge pipes from the jackets leading to the feed-water pumps for the boiler. The cylinder heads contain three valves each, an inlet and two exhaust valves, each in a cage, so as to be easily removed and repaired. The two exhaust valves are mechanically operated, and the inlet may be. The main exhaust is a balanced piston-valve and opens into a passage leading directly to the turbine. Into this passage is also led the steam from the boiler above, so that a complete mixture of the gases occurs before they are delivered to the turbine. The auxiliary exhaust opens to the atmosphere.

The action is as follows: At each stroke, one cylinder contains a fresh charge of gas, the compression of which raises its pressure to about 90 pounds. It is then ignited and the pressure rises to about 325 pounds and falls throughout the forward or expansion stroke. The exhaust valve then opens and the products of combustion are forced into the turbine, first mingling with the steam from the boiler, thus insuring that it is delivered to the turbine in a perfectly dry and probably superheated state and at the same time lowering the excessive temperature and velocity of the gases and thus preventing their destructive effects on the turbine. At about four-fifths of the exhaust stroke, the exhaust valve closes and the auxiliary exhaust opens and remains so until the end of the stroke, thus insuring complete expulsion of the burnt gases and atmospheric pressure in the cylinder at the beginning of the induction stroke. It is true that when the exhaust valve opens the gas engine is then working against the full pressure in the turbine as a back pressure, but the action is somewhat similar to that in a compound engine when the high-pressure cylinder is exhausting into the low-pressure, the effective forward effort being, in the latter case, the area times the difference in pressure on the two pistons. Consequently this back pressure does not constitute a loss. As the engine runs at about 750 revolutions per minute, the exhaust is practically a continuous stream of hot gases at constant pressure, which, mingling with the steam, furnishes the ideal conditions for a wet-gas turbine. There seems to be no reason why such a combustion should not be more efficient than the ordinary explosive-engine. For we have evaded the two greatest sources of loss in the reciprocating gas engine, viz., heat lost to the jacket water, and heat lost in the exhaust. These seldom amount to less than 60 or 80 per cent of the total heat energy in the gas. At the same time we have obtained conditions very favorable for the operation of a gas turbine in which the products of combustion are mixed with steam, a type which, in the opinion of some of the highest engineering authorities, holds forth the best promises in the gas-turbine line.

That this class of motors has attracted the attention of engineers is evident from the appearance in a recent number of one of the technical magazines, of a lengthy article by Mr. Thwaite, of England, on the possibilities of such a motor. He, however, while confident of a marked gain in efficiency, held the opinion that the principle was applicable to large units only. There is little doubt but that the results would be more apparent and more gratifying than in the case of the small unit. A motor based on this principle has been patented by Thomas G. Saxton, of Lexington, Ky., and the inventor is now building an experimental engine. In the general design several unique features may be noted, two elevations being shown in Figs. 1 and 2. The cylinders of the gas engine are opposed in pairs and in order to bring them as closely together as pos-

sible, and at the same time to keep the connecting-rod as long as possible, one rod is made to serve for both cylinders. This is accomplished by joining the two pistons by a rigid cage in which the single connecting-rod works. The advantage of this arrangement over the ordinary trunk piston is apparent. In the geometric center of the four cylinders is located a vertical cone-shaft which is geared to one shaft of the engine. By locating the cone-shaft in this place, two sets of cones are made to answer for the four cylinders. In the valve design, mechanical simplicity has been sacrificed for consideration of economical operation. The valves are all placed in the cylinder-head and no pockets are formed; thus a minimum radiating surface is offered to the gases. The valves are all designed as large as possible, so as to prevent wire-drawing. The boiler has a small superheating dome located above it. The turbine, as has been said, is of the radial type; a rotating disk with blades arranged radially on each side, these blades revolving between stationary blades in the casing of the turbine. As steam is admitted to both sides of the disk, the turbine is perfectly balanced.

The general arrangement of the motor, all the shafts being vertical, permits of an excellent system of lubrication, all the bearings running in oil, which is fed in at the top and discharged at the bottom.

It is believed that this motor will be particularly suited for marine work, the propulsion of small launches, etc. With slight modification it might be used for automobile propulsion. But its possible use in marine work has led to an attempt to conform its design throughout to the demands of this class of work.

CONCRETE BUILDING BLOCKS.*

By S. B. NEWBERRY.

WATER-PROOF QUALITIES.

THE chief fault of concrete building blocks, as ordinarily made, is their tendency to absorb water. In this respect they are generally no worse than sandstone or common brick; it is well known that stone or brick walls are too permeable to allow plastering directly on the inside surface, and must be furred and lathed before plastering, to avoid dampness. This practice is generally followed with concrete blocks, but their use and popularity would be greatly increased if they were made sufficiently waterproof to allow plastering directly on the inside surface.

For this purpose it is not necessary that blocks should be perfectly waterproof, but only that the absorption of water shall be *slow*, so that it may penetrate only part way through the wall during a long-continued rain. Walls made entirely water-tight, are, in fact, objectionable, owing to their tendency to "sweat" from condensation of moisture on the inside surface. For health and comfort, walls must be slightly porous, so that any moisture formed on the inside may be gradually absorbed and carried away.

Excessive water-absorption may be avoided in the following ways:

1. Use of Properly Graded Materials.—It has been shown by Feret and others that porosity and permeability are two different things; porosity is the total proportion of voids or open spaces in the mass, while permeability is the rate at which water, under a given pressure, will pass through it. Permeability depends on the *size* of the openings as well as on their total amount. In two masses of the same porosity or percentage of voids, one consisting of coarse and the other of fine particles, the permeability will be greater in case of the coarse material. The least permeability, and also the least porosity, are, however, obtained by use of a suitable mixture of coarse and fine particles. Properly graded gravel or screenings, containing plenty of coarse fragments and also enough fine material to fill up the pores, will be found to give a much less permeable concrete than fine or coarse sand used alone.

2. Use of Rich Mixtures.—All concretes are somewhat permeable by water under sufficient pressure. Mixtures rich in cement are of course much less permeable than poorer mixtures. If the amount of cement used is more than sufficient to fill the voids in the sand and gravel, a very dense concrete is obtained, into which the penetration of water is extremely slow. The permeability also decreases considerably with age, owing to the gradual crystallization of the cement in the pores, so that concrete which is at first quite absorbent may become practically impermeable after exposure to weather for a few weeks or months. There appears to be a very decided increase in permeability when the cement is reduced below the amount necessary to fill the voids. For example, a good mixed sand and gravel weighing 123 pounds per cubic foot, and therefore containing 25 per cent voids, will give a fairly impermeable concrete in mixtures up to 1 to 4, but with less cement will be found quite absorbent. A gravel with only 20 per cent voids would give about equally good results with a 1 to 5 mixture; such gravel is, however, rarely met with in practice. On the other hand, the best sand, mixed fine and coarse, seldom contains less than 33 per cent voids, and concrete made from such material will prove permeable if poorer than 1 to 3.

Filling the voids with cement is a rather expensive method of securing waterproof qualities, and gives stronger concretes than are needed. The same may be accomplished more cheaply by replacing part of the cement by slaked lime, which is an extremely fine-grained material, and therefore very effective in clos-

* Reprint of a monograph issued by the Association of American Portland Cement Manufacturers.

ing pores. Hydrate lime is the most convenient material to use, but nearly as costly as Portland cement at present prices. A 1 to 4 mixture in which one-third the cement is replaced by hydrate lime will be found equal to a 1 to 3 mixture without the lime. A 1 to 4 concrete made from cement 1, hydrate lime ½, sand and gravel 6 (by weight), will be found fairly water-tight, and much superior in this respect to one of the same richness consisting of cement 1½, sand and gravel 6.

The cost of lime may be greatly reduced by using ordinary lump lime slaked to a paste. The lime must, however, be very thoroughly hydrated, so that no unslaked fragments may remain to make trouble by subsequent expansion. Lime paste is also very difficult to mix, and can be used successfully only in a concrete mixer of the pug-mill type. Ordinary stiff lime paste contains about 50 per cent water; twice as much of it, by weight, should therefore be used as of dry hydrate lime.

3. Use of a Facing.—Penetration of water may be effectively prevented by giving the blocks a facing of richer mixture than the body. For the sake of smooth appearance, facings are generally made of cement and fine sand, and it is often noticed that these do not harden well. It should be remembered that a 1 to 3 sand mixture is no stronger and little if any better in water absorption than a 1 to 5 mixture of well graded sand and gravel. To secure good hardness and resistance to moisture a facing as rich as 1 to 2 should be used.

4. Use of an Impervious Partition.—When blocks are made on a horizontal-face machine, it is a simple matter, after the face is tamped and cores pushed into place, to throw into each opening a small amount of rich and rather wet mortar, spread this fairly evenly, and then go on tamping in the ordinary mixture until the mold is filled. A dense layer across each of the cross-walls is thus obtained, which effectually prevents moisture from passing beyond it. A method of accomplishing the same result with vertical-face machines, by inserting tapered wooden blocks in the middle of the cross-walls, withdrawing these blocks after tamping and filling the spaces with rich mortar, has lately been patented by Purdy & Henderson, of New York. In the two-piece system the penetration of moisture through the wall is prevented by leaving an empty space between the web of the block and the inside face, or by filling this space with rich mortar.

5. Use of Water-Proof Compounds.—There are compounds on the market, of a fatty or waxy nature, which, when mixed with cement to the amount of only one or two per cent of its weight, increase its water-resisting qualities in a remarkable degree. By thoroughly mixing 1 to 2 pounds of suitable compound with each sack of cement used, blocks which are practically water-proof may be made, at very small additional cost, from 1 to 4 or 1 to 5 mixtures. In purchasing water-proof compound, however, care should be taken to select such as has been proved to be *permanent* in its effect, as some of the materials used for this purpose lose their effect after a few days' exposure to weather, and are entirely worthless.

6. Application to Surface After Erecting.—Various washes, to make concrete and stone impervious to water, have been used with some success. Among these the best known is the Sylvester wash of alum and soap solution. It is stated that this requires frequent renewal, and it is hardly likely to prove of any value in the concrete industry. The writer's experience has been that the most effective remedy, in case a concrete building proves damp, is to give the outside walls a *very thin* wash of cement suspended in water. One or two coats will be found sufficient. If too thick a coating is formed it will show hair cracks. The effect of the cement wash is to make the walls appear lighter in color, and if the coating is thin the appearance is in no way injured.

General Hints on Water-Proof Qualities.—To obtain good water-resisting properties, the first precaution is to make the concrete *sufficiently wet*. Dry-tamped blocks, even from rich mixture, will always be porous and absorbent, while the same mixture in plastic condition will give blocks which are dense, strong, and water-tight. The difference in this respect is shown by the following tests of small concrete blocks, made by the writer. The concrete used was made of 1 part cement and 5 parts mixed fine and coarse sand, by weight.

No. 1. With 8 per cent water, rather drier than ordinary block concrete, tamped in mold.

No. 2. With 10 per cent water, tamped in mold, too wet to remove mold at once.

No. 3. With 25 per cent water, poured into a mold resting on a flat surface of dry sand; after 1 hour the surface was troweled smooth; mold not removed until set.

These blocks were allowed to harden a week in moist air, then dried. The weights, voids, and water absorption were as follows:

| | 1 | 2 | 3 |
	Damp-tamped.	Wet-tamped.	Poured.
Weight per cubic foot, pounds..	122.2	123.9	110.0
Voids, calculated, per cent of volume	25.9	24.9	33.3
Water required to fill voids, per cent of wt.	9.8	9.4	12.5
Water absorbed after 2 hours, per cent of wt.	8.8	6.4	10.5

The rate at which these blocks absorbed water was then determined by drying them thoroughly, then

placing them in a tray containing water ¼ inch in depth, and weighing them at intervals.

Water absorbed per cent by weight.	1 Damp-tamped.	2 Wet-tamped.	3 Poured.
½ hour	2.0	0.9	1.8
1 hour	3.2	1.1	2.5
2 hours	4.1	1.6	3.2
4 hours	5.2	2.0	3.8
24 hours	6.1	3.4	7.0
48 hours	6.4	4.3	7.5

These figures show that concrete which is sufficiently wet to be thoroughly plastic absorbs water much more slowly than drier concrete, and prove the importance of using as much water as possible in the damp-tamping process.

COST.

The success of the hollow concrete block industry depends to a great extent on cheapness of product, since it is necessary, in order to build up a large business, to compete in price with common brick and rubble stone. At equal cost, well-made blocks are certain to be preferred, owing to their superiority in strength, convenience, accurate dimensions, and appearance. For the outside walls of handsome buildings, blocks come into competition with pressed brick and dressed stone, which are, of course, far more costly. Concrete blocks can be sold and laid up at a good profit at 25 cents per cubic foot of wall. Common red brick costs generally about $12 per thousand, laid. At 24 to the cubic foot, a thousand brick are equal to 41.7 cubic feet of wall; or, at $12, 29c. per cubic foot. Brick walls with pressed brick facing cost from 40 cents to 50 cents per cubic foot, and dressed stone from $1 to $1.50 per foot.

The factory cost of concrete blocks varies according to the cost of materials. Let us assume cement to be $1.50 per barrel of 380 pounds, and sand and gravel 25 cents per ton. With a 1 to 4 mixture, 1 barrel cement will make 1,900 pounds of solid concrete, or at 130 pounds per cubic foot, 14.6 cubic feet. The cost of materials will then be

Cement, 380 pounds	$1.50
Sand and gravel, 1,500 pounds	0.19
Total	$1.69

or 11.5 cents per cubic foot solid concrete. Now, blocks 9 inches high and 32 inches long make 2 square feet of face of wall, each. Blocks of this height and length, 8 inches thick, make 1 1-3 cubic feet of wall; and blocks 12 inches thick make 2 cubic feet of wall. From these figures we may calculate the cost of materials for these blocks, with cores or openings equal to 1-3 or ½ the total volume, as follows:

Per cubic foot of block, 1-3 opening	7.7 cts.
Per cubic foot of block, ½ opening	5.8 cts.
Block 8 x 9 x 32 inches, 1-3 opening	10.3 cts.
Block 8 x 9 x 32 inches, ½ opening	7.7 cts.
Block 12 x 9 x 32 inches, 1-3 opening	15.4 cts.
Block 12 x 9 x 32 inches, ½ opening	11.6 cts.

If one-third of the cement is replaced by hydrate lime the quality of the blocks will be improved, and the cost of material reduced about 10 per cent.

The cost of labor required in manufacturing, handling and delivering blocks will vary with the locality and the size and equipment of factory. With hand-mixing, 3 men at average of $1.75 each will easily make 75 8-inch or 50 12-inch blocks, with 1-3 openings, per day. The labor cost for these sizes of blocks will therefore be 7 cents and 10½ cents respectively. At a factory equipped with power concrete mixer and cars for transporting blocks, in which a number of machines are kept busy, the labor cost will be considerably less. An extensive industry located in a large city is, however, subject to many expenses which are avoided in a small country plant, such as high wages, management, office rent, advertising, etc., so that the total cost of production is likely to be about the same in both cases. A fair estimate of total factory cost is as follows:

	Material.	Labor.	Total.
8 x 32 inch, 1-3 space	10.3	7	17.3 cts.
8 x 32 inch, ½ space	7.7	6	13.7 cts.
12 x 32 inch, 1-3 space	15.4	10.5	25.9 cts.
12 x 32 inch, ½ space	11.6	9	20.6 cts.

With fair allowance for outside expenses and profit, 8-inch blocks may be sold at 30 cents and 12-inch at 40 cents each. For laying 12-inch blocks in the wall, contractors generally figure about 10 cents each. Adding 5 cents for teaming, the blocks will cost 55 cents each, erected, or 27½ cents per cubic foot of wall. This is less than the cost of common brick, and the above figures show that this price could be shaded somewhat, if necessary, to meet competition.

APPEARANCE AND USE.

Since concrete blocks are, as has been shown, more convenient, more efficient, and cheaper than any other building material, it would naturally be expected that they would quickly take the place of wood, brick, and stone and be generally adopted for all ordinary construction. The growth of the block industry has, indeed, been rapid, but it plays as yet but a small part in the building operations of the country. It is evident on all sides that concrete blocks meet with opposition and suspicion on the part of architects and builders, and in consequence are much less generally adopted than their merits appear to warrant. It is neither just nor expedient to attribute this opposition to prejudice against a new material. Rather should we try to find and remove the grounds on which such oppo-

sition is based. My observation leads me to believe that architects and engineers have no prejudice against concrete, but on the contrary, welcome it as a building material by means of which they can obtain results never before within their reach. And they are also keenly watching the block industry, and are ready to adopt block construction as soon as they are offered a product which meets their ideas as to utility and beauty.

Fortunately, no material is so elastic in its capabilities as concrete, and no other can with so little effort be adapted to produce any effect desired. It is hardly to be expected that the block of the present day will be the block of the future; the type which is most economical, practical, and beautiful will gradually come to the front, and that which is costly, clumsy, and ugly will become a thing of the past. To make a success of the business we must keep our eyes open, watch what others are doing in the way of invention and improvement, and study the wants of customers. And we must not hesitate to throw our old block machines into the scrap heap when we are sure we have found a better apparatus and process.

The objections which architects and builders make to blocks now on the market are chiefly the following:

Poor workmanship.

Fixed dimensions.

Too great weight.

Unpleasing appearance.

As to workmanship, shoddy, weak, and crumbling blocks are far too often met with. Good concrete should be hard and dense, and should give out a musical tone when struck with a hammer. If your blocks sound dead when struck, and break easily with an earthy fracture, you are either using too poor a mixture or working too dry, probably the latter. It does not pay, for the sake of low factory cost, to turn out work of this kind. If there is any money to be made in the block business it will be made by furnishing a good article at a living price, and in no other way. Will any one argue that it pays to make rotten blocks at a factory cost of two cents less than good ones? My belief is that the tendency of the future will be toward the use of wetter concrete, and the adoption of a process which makes this possible.

As to fixed dimensions of blocks, the standard length of 32 inches, divided into halves, thirds, and quarters, is very convenient, and is generally conformed to by architects, for simple work, without much objection. To be fully successful, however, and to overcome all prejudice, the blockmaker must be ready to furnish any size or shape that may be called for to suit architects' designs. It would be very pleasant if we could confine ourselves to the standard size and let customers "take it or leave it." But such an attitude bars the way to any wide use of blocks in varied and attractive buildings, and cannot be maintained without loss of trade. Architects want also courses of greater or less height than the 9-inch standard, and all manner of cornices, copings, columns, and capitals. This may frighten the timid and conservative blockmaker, but it is in that direction that success lies, and the production of these special shapes requires only ingenuity, courage, and mechanical skill. Until we can say to the architect "Design whatever you like, we'll make it for you," he will shy at us and our product. He will, of course, readily appreciate that special shapes cost more than standard, and if he knows he can get just what he wants he will be more likely to accept, so far as he can, what can be conveniently and cheaply furnished.

Preference should be given, therefore, to the machine which permits the greatest variety of sizes and shapes to be easily made. And the greatest business success is likely to come to the manufacturer who shows the least inclination to get into a rut, and is most ready to adapt his product to the wants of his patrons.

The objection to the weight of the one-piece block comes chiefly from masons and contractors. Hoisting 12 x 32-inch blocks weighing 180 pounds to the upper floors of a building, and handling them on to the wall, is a considerable task, and it is largely on this account that the half-block of the two-piece system, 24 inches long, weighing only 64 pounds, is received with so much favor. It must be remembered, however, that the two-piece blocks make a wall with over 50 per cent opening, and a one-piece block of the same thickness of walls—2 inches—would also be light to handle and doubtless very popular. My belief is that the one-piece block of the future will be 24 inches long and with a thickness of walls of not over 2 inches. Such a block, 12 inches wide and 9 inches high, will weigh only 97 pounds, and if well and honestly made will bear rough handling and any possible load.

Finally, it is to the *appearance* of concrete blocks, as ordinarily made and used, that architects and other persons of taste and judgment make the greatest objection. Anything that savors of imitation, that pretends to be what it is not, will always be hated and condemned by all who know the difference between the good and the bad. The common rock-faced block is an imitation of the cheapest form of quarry stone, and a poor imitation at that, for no two natural stone blocks are alike in surface; while even if you have half a dozen rock-face plates of the same size of block, and strive to shuffle up the product of these plates in the yard and on the work, you will never see a building in which, here and there, blocks from the same plate are not found one above or beside the other. And it is surprising how unerringly the eye will pick out the spots where this occurs, and what a feeling of "some-

thing lacking" is awakened. It is bad art, and quite indefensible. The "rock-faced galvanized iron" of our country store-front is a no more glaring fraud. The rock-faced block must go.

Now let us inquire what constitutes imitation, and how concrete may be made to stand on its merits and look like what it really is. In the first place, concrete must always look like stone, because it is stone. An artificial stone, consisting of grains of sand and gravel or limestone crystals bound together by a little Portland cement, cannot help looking like natural sandstone or limestone made up of the same materials bound together by carbonate of lime or soluble silicates slowly deposited in its pores. We need never be afraid that concrete will be condemned for its stony look, since that is its nature. All we need to avoid is giving the work an appearance which is unnatural to concrete, such as the rock-face. Smooth, ribbed and paneled surfaces, also good ornamental patterns for friezes or cornices, are entirely legitimate, and equally characteristic of stone, metal, terra cotta, or concrete. Forms of beauty may properly be reproduced in any material; the only thing to be avoided is pretense—the attempt to deceive the observer into the belief that the material he sees is something different from what it really is.

The surface which best pleases the eye of artist and architect is a rough and varied one, rather than the smooth, dead look which rich cement mixtures have. The film of cement which coats the face of the work is certainly monotonous and unattractive. This can be cheaply removed by washing with very weak acid, and very beautiful effects are thus obtained, especially with crushed stone or gravels containing pebbles of various colors.

POLISHING WHEELS.

Polishing or buff wheels are used for imparting a smooth, glossy finish to metallic surfaces, akin to that which is produced by the burnisher. The latter, how-

No. 1.　　Fig. 2.
Fig. 3.　　Fig. 4.
Fig. 5.　　Fig. 6.
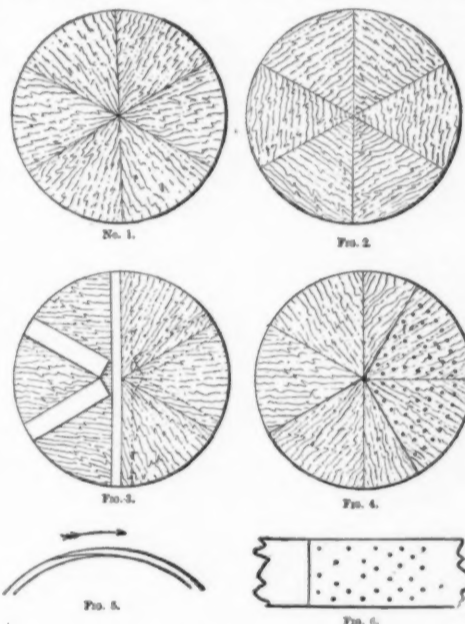
ever, is laborious and slow in action, while the former is accomplished rapidly. Polishing wheels are also capable of removing a considerable quantity of material; but that is not their legitimate function, nor is it desirable to use them thus, because the solid emery wheels are so much better adapted for this kind of work. The bulk of the material should be removed with these, and the polishing only done with the buff wheel. Polishing wheels were used for both purposes years ago before the solid wheels finally displaced them.

While the solid wheels are made entirely of emery, cemented, and pressed together, the polishing wheels are built up of wood, and covered with leather, and the emery is cemented to the surface only. Since they have to be run at a very high speed, equal to, or higher than, that of the solid wheels, great caution has to be observed in so building them up that they shall not part and fly asunder during working. The method of making them in such a way that this accident is not likely to occur is as follows:

The center, of wood, is built up in a similar fashion to built-up pattern work—that is, with segments breaking joints. The best material to use is yellow pine. Each course of segments must be thin, say, from ¾ inch to ⅝ inch thick, and each segment should be of small area. In no case would there be fewer than six segments to the circle, while in the large wheels, say, of over 12 inches or 14 inches in diameter, eight segments would be used. The reason of these precautions is obvious. However well wood is seasoned, it is sensitive to atmospheric changes. By using small, thin segments, the possible alterations in form of any single segment due to these changes is minimized, so that the wheel as a whole will remain practically unaffected by heat, dryness, or moisture. The employment of small segments does not render a wheel weaker, but stronger, because each segment binds, and is bound by others.

The arrangement of the timber grain is shown in

Fig. 1, being better than that in Fig. 2. The latter is more convenient for gluing the leather upon the periphery, because glue holds much better to the plank way of the grain than it does to end grain, as in Fig. 1. But the reason why that arrangement is more suitable than Fig. 2 is because there is little

REAR VIEW OF THE MOTOGODILLE RAISED OUT OF THE WATER.

risk of pieces of the segments becoming detached and flying off. It is easy to see in the second figure that there is a risk of pieces parting from the segments near the outer edges, and flying off by centrifugal force. With regard to the lack of holding power of the glue on the end grain in Fig. 1, the difficulty is got over by thoroughly filling up the end grain with plenty of glue before wrapping the leather round, and by taking especial care in the insertion of the pegs, both in respect of number, position, and hold in the wood.

When building up the center, the first course of segments is glued upon a wooden face-plate, not directly, but with strips of paper intervening between the plate and the segments. The strips are narrow, being placed under the edge joints. Fig. 3 shows the face of the plate with three segments glued on, and three strips of paper not yet covered. The edge joints of the segments must be glued. The glue used must not be too watery; it must be as thick as can be conveniently used. So much depends upon its holding power, that thin, watery glue which would be suitable for pattern work, would dry and crack and fail to hold in an emery wheel. Further, the glue should be newly made for such a job as this.

When the glue is dry, the segments are faced off in the lathe, and the second set fitted and glued on. Fig. 4 shows two segments of the second course in place. The breaking of the joints, and the pegs, are seen clearly. The pegs are cut from pine, about 3/16 inch square in section, and the holes bored with a ⅛-inch bradawl. The pegs are dipped in glue, and driven in at distances of about 1 inch to 1½ inch apart. In this way the whole of the segments are all built up.

The wheel is next bored to fit its spindle and is then turned up on its spindle. Or, if turned on the face-plate, it must be afterward lightly finished on its spindle. When the outside diameter runs true the leather is glued on. This is first soaked in water to render it pliable, and the meeting ends are fitted with a long scarfed joint of from 3 inches to 4 inches in length. The wheel revolving in the direction indicated in Fig. 5, the arrangement of the scarf is that shown. The hair side of the leather is laid next the wood, the grain of the wood is well saturated and filled up with glue, and the leather strained round taut and pegged well, as shown in Fig. 6. The work must be done in detail—that is, only as much of the leather must be glued at a time as can be pegged quickly. From 4 inches to 6 inches in length is enough to take at once, and then another section may be taken.

The emery powder is attached with glue to the leather, and the wheel rolled then in the emery until sufficient adheres. In cold weather the emery should be warmed in order not to chill the glue. When dry and hard it is ready for use.

To recoat a wheel which has worn smooth or uneven, the emery and glue must be wholly cleaned off. The glue may be softened with hot water and scraped off. The water is best applied with wipers or waste laid round the wheel. Then the original process of gluing and rolling the wheel is repeated.—English Mechanic and World of Science.

In law a nuisance is "such a use of property or such a course of conduct as, irrespective of actual trespass against others or of malicious or actual criminal intent, transgresses the just restrictions upon use or conduct which the proximity of other persons or property in civilized communities imposes upon what would otherwise be rightful freedom." (Century Dictionary.) Smoke is then a nuisance and can be prohibited by State or municipal enactment as the case may be. I have no more right to deluge my neighbor's premises with soot than I have to empty my garbage can over the fence line. The abatement of smoke is in principle extremely simple, but presents some difficulties in the practical application.

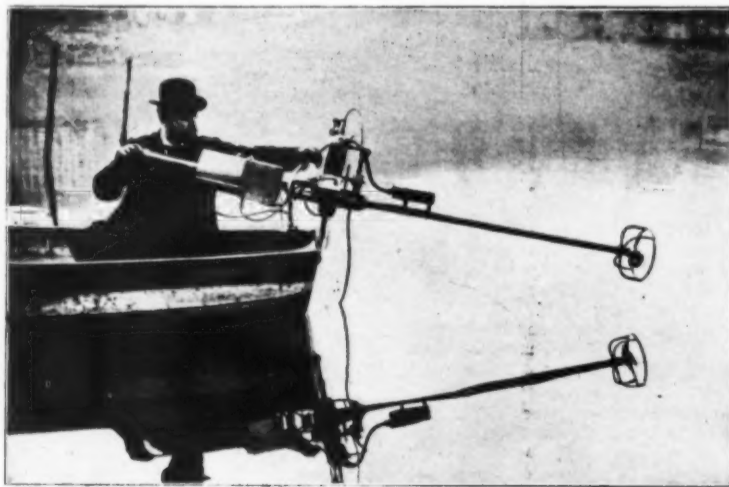## THE "MOTOGODILLE," A MOTOR DEVICE FOR PROPELLING SMALL BOATS.

An interesting device in the way of applying a motor to small craft has been brought out by G. Trouche & Company and constructed at the Buchet works near Paris, which is well known for its different types of light automobile and airship motors. The apparatus has been designed to afford a very simple as well as inexpensive method of applying a small gasoline motor to boats, and it differs considerably from anything else which has been seen heretofore. It consists of a motor-driven propeller which is adapted to be placed on the

TRAVELING WITH THE MOTOGODILLE AT FULL SPEED ON THE RIVER SEINE.

boat; but contrary to other apparatus and motors which require to be specially built and installed in the boat so as to form part of the latter, it forms an entirely separate mechanism that is fitted to the stern of the craft in a few minutes, and that allows of instantly transforming any ordinary boat into a motor-driven craft without any change whatever in the boat itself. By applying a simple socket-piece to the stern with

four screws or bolts, the propelling apparatus, which fits in the socket by means of a pin in about the same way as a steering oar, can be immediately installed. The new propeller device, which is known as the "Motogodille," is of extra light, simple, and strong construction, and forms a single rigid piece having but a single contact with the boat. It serves to propel and steer the craft at the same time and also to change the

speed. The socket and the support of the apparatus form a kind of universal joint which allows the pilot to raise the propeller or to plunge it to the required depth so as to vary the speed of the boat, or else to displace it to the right or left for steering. These movements are all carried out with one hand and without any more fatigue than is felt when using a rudder. As the propeller is mounted on a long shaft and works at a distance of 4 feet 6 inches from the stern, it runs in comparatively still water and gives a much better propelling effect than usual. The variable immersion of the propeller allows it to work with a flat-bottomed boat in very shallow water. A speed varying from 5 to 10 miles an hour is obtained (according to the size of motor which is used) with an ordinary boat containing 5 or 6 persons, with a consumption of 0.3 gallon of gasoline. At present two sizes are made, one of 1¼ horse-power weighing 35 pounds, and a second giving 2½ horse-power and weighing 90 pounds. A very practical application of the device is upon sail-boats, as it will bring the boat into port in case of a calm, and it can easily be stowed in the hold. As will be noticed the motor is mounted upright just over the main pivot which works in the boat. Back of the motor and fixed on the steering bar is a box with sliding cover for the battery and spark coil. Above it is a cylindrical gasoline tank.

TO KEEP PIPES FROM FREEZING.

At the beginning of each winter the question arises anew, how best to protect exposed water pipes, pumps, etc. Unless precautions are taken, the expansion of the water in freezing will burst the pipes, causing inconvenience and even disaster. The continual thawing-out process necessary to keep the water in circulation not only involves a great deal of trouble, but is often injurious to the apparatus. Lead pipes, for instance, cannot withstand the action of a hot fire.

The means generally employed to prevent the pipes from freezing consists in the use of coatings which protect against cold, and non-conductors of heat, such as straw, cork, and oakum. There are, however, more effective agents, also practicable for use in thawing frozen pipes. The pipes are first covered with a thin layer of straw, sawdust, or tan-bark. Pieces of un-slaked lime, as large as the fist, are then packed around them, and enveloped in another layer of some non-conducting material, straw, oakum, or cork; and the whole is held firmly together by means of a wrapping of coarse linen. The first layer is for the purpose of protecting the pipes from the action of the fresh lime, which would cause the metal to rust. The lime draws moisture from the air and the materials surrounding it, and is made warm by means of the chemical reaction. The outer covering allows only a small amount of atmospheric air to pass through, so that enough of the lime remains unslaked to keep up the temperature during an entire winter.

This method, with slight variations, can be applied to the thawing out of frozen pipes. For this purpose somewhat more lime is to be packed around the pipes, and water poured over it. The heat generated will melt the ice in the pipes. The ground in winter can also be thawed out in this way, when, for example, it is desired to lift paving stones without breaking.—La Technologie Sanitaire.

ENAMELING ON IRON.

The processes which are now employed in Europe for enameling iron are reviewed by J. Schlemmer. In the first stage of development, the process used consisted in powdering the enamel upon the object, but as this proved very defective it was soon replaced by the wet application of the enamel. The most widely-used process for enameling cast iron is the method of spread-

SIDE VIEW OF THE MOTOGODILLE WHEN RAISED OUT OF THE WATER.

ing a very fine powder of enamel colors by means of a brush. The object is heated and coated successively a number of times. But these enamels have a low resistance and are easily destroyed by atmospheric influences, also from their great fusibility and by the fact that they are saturated with oxides and coloring matters. This process was replaced by the dusting-on method which came again into favor owing to the

superiority of the enamel it gave. It has a disadvantage, however, in forming a dust containing lead, which is bad for the workmen's health. This fact brought a new application by the wet way in which this disadvantage was partly overcome. The use of lead is almost indispensable for obtaining the desired colors. The method of hot dusting on gives a good colored enamel, especially of the majolica kind, but the same effect is obtained by the wet process by cleaning the iron before enameling. Soon the method which consists in applying a wet paste of enamel became general. The enamel is poured upon the object while it is continually revolved about. But this process requires a first coat of enamel, which needs to be different from the second or glaze coat in composition, and this for two reasons: first, to absorb the carbonate of iron on the surface, and, second, to form a middle layer which will take up the expansion of the glazing. For this reason we use a first coat of enamel containing a certain amount of clay or quartz, but too much must not be used or the enamel will not adhere well to the iron. The first coat usually has a dark appearance. A thin coat of good enamel is preferred, as it attaches better to the iron than a thick layer. We mention a new process of enameling which deserves some attention. It consists in applying the outer glaze by means of a compressed-air blower called "aerograph." The mass of enamel is blown in a wet state as a fine shower upon the objects. Very uniform layers are thus secured which cover the objects perfectly and give good results, especially in the difficult process of enameling certain ornaments. It seems that this method cannot, however, be applied to the use of lead glaze on a large scale in factories, seeing that even by the wet process we have a very dangerous dust which can be carried off in a small plant, but can scarcely be taken care of in a large one.

THE PRODUCTION OF NATURAL GASTRIC JUICE.

UPON the road from Bougival to Versailles, at the culminating point of the plain that overlooks the valley of the Seine, amid the woods and great domains of Rocquencourt and Celle-Saint-Cloud (Seine-et-Oise), is situated the farm of Puits d'Angle, which, for a year past, has been used as an industrial laboratory for the production of natural gastric juice. This latter is a therapeutic product belonging to the group of opotherapic medicines and designed for the treatment of stomach diseases. Opotherapy is a method that consists in treating a diseased organ by an extract or secretion of the same organ taken from some animal. The fragility of the mucous membrane of the stomach, which undergoes a change immediately after death and enters into action only at the moment of digestion, prevents extracts possessing the virtues of the natural secretion from being obtained by ordinary chemical means. So, for some years past, Pavlow in Russia, and Frémont in France, have been trying to obtain the secretion from the stomach in a sufficient state of purity for therapeutic use; but their studies have been exclusively directed to the gastric secretion of the dog. Now to the disadvantages presented, from a therapeutic standpoint, by the secretion of this animal (undue acidity, disagreeable odor, and general repugnance of man to all canine products) is added the difficulty of operating upon a certain number of dogs kept in confinement and of maintaining them in a perfect state of health. It is for these various reasons that the idea occurred to Dr. Hepp to try the physiological experi-

FIG. 1.—VIEW OF AN OPERATION IN THE LABORATORY PUITS D'ANGLE.

ments of Pavlow and Frémont upon that omnivorous animal, the hog. After several years of experiment, he has succeeded, through an original mode of operation, in obtaining from this animal a regular production of gastric juice in sufficient quantities to make it the object of a genuine industry.

Various physiologists have, through a simple gastric fistula, been able to collect gastric juice, but it is impossible to think of utilizing a juice mixed with food for administration to the sick. It was necessary to

obtain the juice in a pure state, and this the stomach secretes only during the digestive period. In order to collect the juice at such a period, it was therefore necessary to divert the food from the stomach, and, at the same time, to preserve the connections of this organ. To obtain such a result, Dr. Hepp severs the œsophagus above the cardia, at the same time preserving the pneumogastric nerves. He then implants the œsophagus upon the duodenum, and, finally, forms a

FIG. 3.—EXTRACTING GASTRIC JUICE FROM A HOG.

gastric fistula that permits of collecting the secretion. Owing to this, the food does not pass through the stomach, which, nevertheless, secretes abundantly at the moment of eating; and it suffices to introduce a cannula into the fistula, after a meal, in order to collect a large quantity of gastric juice, of which the surplus, running into the duodenum through the open pylorus, maintains the physiological equilibrium of the animal operated upon. In spite of this surgical operation, the seriousness and complexity of which will be apparent to every one, the animals that have been submitted to it live, eat and thrive. In fact, animals operated upon at the age of 3 or 4 months and weighing, say 110 pounds, reach a huge size (Fig. 3), and on the Puits d'Angle farm there are some to be seen that were operated upon three years ago and that now weigh 485 pounds. All this goes to show that the health of these animals remains perfect—a condition that is indispensable for the therapeutic utilization of their organic secretions. It is unnecessary to say that very special care is taken of the animals, and that the sty of the Puits d'Angle farm in nowise resembles the dark and foul pen in which hogs are usually reared. The animals, in fact, live the entire day in the open air, and their food, which is all selected, consists of potatoes, bran, barley flour, smoked meat and buttermilk. About three quarters of an hour after they have been fed, the

FIG. 2.—APPARATUS FOR FILTERING GASTRIC JUICE.

animals are suspended by means of a special harness that permits of an easy extraction of their secretion by simply inserting a cannula into their previously asepticized fistula (Fig. 3). The animals, which are in fine condition, lend themselves very readily to this twice-daily operation, to which they quickly become accustomed.

The juice collected is immediately carried to the laboratory, where it is treated by simple decantation, and then by filtration in sterilized asbestos cylinders of

the Mallié type. Upon coming from the filters it is perfectly sterilized and presents the appearance of an amber-colored liquid of perfect limpidity, which may be preserved for an indefinite length of time, provided that it be bottled under special aseptic conditions.

The therapeutic results obtained by the use of natural gastric juice are now numerous and of the greatest interest. It is used in all cases in which the functions of the stomach are not properly performed, say by reason of some disease of the organ itself (as in gastritis, dilatation, etc.), or of an intestinal affection, especially in chronic diarrhea, and infantile gastroenteritis, in which its action is exceedingly prompt and remarkable, or by reason of a general consumptive disease, particularly pulmonary tuberculosis, in which it possesses the valuable property of very quickly restoring the appetite and digestive faculties, even in patients in whom the disease has reached an advanced stage, and of thus permitting of a superalimentation, which, as is well known, is the sole efficacious process of treating and effecting the cure of such unfortunates. —Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

TREATMENT FOR ELECTRIC SHOCK.

AMONG the papers read before the recent meeting of the Ohio Electric Light Association was one by E. E. Noble on "Resuscitation from Electric Shock." Commenting upon this the Electrical Review declares that the topic deserves thorough discussion, as any additional light that can be thrown upon the effect of electric shocks is of great value. Not only should every physician be familiar with the effects of an electric shock upon the human system, but every worker about electric plants of any kind who is at all exposed to shocks, even though of low voltage, should be taught the best methods to be applied to resuscitate a victim.

"As is well known," the Electrical Review continues, "the treatment to revive a person rendered unconscious by an electric shock is similar to that used to revive those rendered unconscious from lack of air. Some suitable method of producing artificial respiration should be applied immediately and kept up until all possible doubt of death has been removed, always until a physician arrives to take charge. The effect of the current is first to stop the action of the heart and lungs, and if this can be restored the victim will generally recover, provided no other injury has resulted. When, however, current has been applied for a longer time, the vital organs of the body may be so injured as to make death certain.

"That part of Mr. Noble's paper which lays stress upon immediate and faithful work with the patient we heartily indorse, but there is some question in regard to other portions. Results are given of experiments on animals with comparatively high voltage, from which the subject suffered no permanent injury. Current was drawn from a 2,300-volt supply in one case, and passed through the brain of a dog for one minute without any bad effect. Other instances equally surprising are mentioned, and then emphasis is laid upon the statement that it is the amount of current which passes through the body, not the voltage, which causes the damage. Unfortunately, the experiments described in the paper are not sufficiently detailed to enable one to understand exactly how they were performed, and they leave some doubt as to whether in speaking of a pressure of 2,300 volts the experimenters do not mean rather the voltage of the supply than the voltage between the two terminals when applied to the animal.

"As is well known, the resistance of the body varies considerably, and the resistance of the contacts is probably even more important. A person might easily suffer no damage from shock obtained from a high-voltage supply, provided only that there was sufficient resistance in the circuit of which he formed a part to reduce the current which passed through his body to a certain value; but this would be in effect reducing

the voltage of the shock. It is not safe to draw conclusions from experiments stated so incompletely, and on the face of them it would be unwise to spread the feeling that electric shocks are much less dangerous than they are supposed to be. It is better to be on the safe side and have a wholesome dread of an electric shock, rather than to be rendered careless by a false feeling of security. We, on the one hand, have no patience with those who are always speaking of the deadly wires, but, on the other hand, we prefer that those who have no business about an electric system should believe that it is dangerous to approach.

"Holding the opinion stated above, that it is the amount of current which passes through the body, and not the pressure applied, which causes the damage, it is suggested by Mr. Noble that a metallic gauze jacket be worn next to the skin by those who are obliged to work on electric systems; or that a system of metallic bracelets, worn around the upper arms and connected by means of flexible conductors, take the place of the metallic jacket. While it is conceivable that such a garment might be useful in some cases, it is a question whether, in other cases, it would not prove a source of danger. The object of these metallic protectors is to shunt any current which might pass through the wearer's body around the heart, and thus prevent inhibition. Now, suppose that contact be made by the two hands, it is a question how much of the current will leave the body at one upper arm to pass through the metallic conductors and back into the other arm. It might happen that the presence of this low-resistance portion of the circuit would cause so much current to pass through the hands and arms as to paralyze them, rendering it impossible for the victim to let go.

"It is possible that a smaller current, applied for a longer time, would cause more danger than a heavier current for a shorter time. Then, too, should by any possible accident this metallic protector itself establish a short-circuit, it is very probable that a terrible burn would result, which might cause death; or the protector itself might serve to establish one good contact with disastrous results. To act as a shunt around a body it should be in intimate connection with the skin, but we doubt if there are many workingmen who would care to wear such a coat of mail next to their bodies. These doubts may prove to be quite unfounded, but the evidence so far presented has not seemed sufficient to warrant any great expectations. On the other hand, it is a good thing to have the matter discussed and the utility of any suggested safeguards carefully investigated and their value determined."

ARTIFICIAL VERSUS NATURAL DYES.
By Prof. O. N. Witt.

As there is no fundamental difference between the chemical processes of nature and those of the laboratory, there is no reason why they should not occasionally lead to identical results. This has actually come to pass. The first artificial dyes, discovered by chance, were very different from those furnished by nature. They increased the resources of the dyer by enabling him to produce tints previously almost unknown, and consequently they were soon used in practice, although they were less permanent than the best natural dyes.

It was the work of pure chance that these particular dyes were first discovered, instead of others with different qualities, good and bad. But the days of chance are past. At present new dyes are not discovered, but invented or constructed according to definite rules, and their distinctive peculiarities, which depend upon the grouping of their atoms, can be predicted in advance. This method of production is called synthesis.

Great scientific as well as technical interest, of course, attaches to the synthetic production of the best of the natural dyes. The colors of the old-time dyer were the result of selection practised for thousands of years. These were the standards with which the artificial dyes must be compared. But why should we expect the very best of the artificial dyes to be discovered first? If, however, the identical natural dyes that had stood the test of long experience could be made by synthesis, the excellence of the artificial products would be assured and the choice between them and the same dyes produced by nature would be merely a question of cost.

That these expectations were justified soon became evident. Aniline had been obtained from indigo, and anthracene from alizarine, the coloring principle of madder. But aniline and anthracene were also found in coal tar, and they constituted the sources of all the new artificial dyes. They might, therefore, be expected to furnish, also, the old and valued dyes, from which they could be obtained by decomposition.

The hope has been realized. The synthesis, on a commercial scale, of indigo and the alizarine dyes is one of the great triumphs of practical chemistry and it has been celebrated so loudly that it might be supposed that every educated person had heard of it and appreciated it. But this supposition takes no account of the persistence and obstinacy of prejudice and of first impressions based on insufficient and inexact data.

The beauty and brilliancy of artificial dyes in general were the properties that first attracted general attention. Next came the rumor, partly founded on improper use of the dyes, that they were not permanent. Hence the common impression that all artificial dyes are brilliant—too brilliant—but fugitive.

Even to this day, when ninety per cent of fabrics are dyed with these artificial colors, such goods are often bought and sold, in deference to this prejudice, as "natural dyed." Even now, after artificial alizarine

has been on the market for thirty-five years and artificial indigo for almost ten years, men who call themselves experts loudly assert that alizarine and indigo are permanent when they are obtained from madder root and the indigo plant, but fugitive when they are made by German chemists.

Such assertions, when they are not conscious falsehoods prompted by self-interest, must be attributed to the doting fondness with which many persons cling to their prejudices in defiance of reason. It might be thought that the opinion of the public and the statements of the false prophets were of little importance. The real experts know what to expect of each of the countless dyes that are now to be had, and when and how each must be used. They know, too, that the public will be satisfied if the colors sold as "fast" prove to be fast in reality.

The real sufferer from the persistence of the prejudice is the consumer, who obstinately refuses to accept and try new dyes of excellent quality and restricts his choice to the few shades of approved permanence that were known to former generations. Tints that are discredited because they are obviously produced by artificial dyes are used reluctantly and sparingly.

The artificial production of the best of the natural dyes themselves, in absolute purity and at small cost, ought to acquit the artificial dye industry of the charge of producing none but inferior and fugitive colors.

Now, however, this industry justly claims, not only to equal, but to surpass nature, and to yield dyes which are far more permanent and reliable than any known vegetable dyes. Why not? The pippin excels the crab. Why should not the chemist improve upon nature as the horticulturist has done?

In order to prove the truth of the assertion that such improvement has actually been effected we must consider the properties which constitute excellence in a dyestuff. For the consumer these are the beauty and the permanence of the color when applied to fabrics.

The question of beauty may be left to the eye. A clear, bright, decided color is always preferred to a muddy, uncertain one because we know that the dyer can subdue the former, if necessary, but he cannot brighten the latter.

The question of permanence is more difficult. There are several varieties of permanence which are not always associated in the same dye. A color that fades when exposed to light may "wash" very well, and one that is insensitive to light may be greatly affected by washing. A color may resist both light and washing, and yet be easily injured by rubbing or by chlorine. Some dyes are affected by ironing. Some "wash" well in other respects but, on long soaking, stain white threads woven with the colored yarn. Wool dyes finally, are variously affected by fulling.

There are very few known dyes that possess all kinds of permanence to a satisfactory degree. Almost every dyestuff, natural or artificial, has its weak point and the art of the dyer is shown in employing each for uses in which its particular defects are of no importance.

Of natural dyes, indigo and the alizarine of madder owe their high reputation to their great permanence. Alizarine, in particular, when dyed on cotton by the "Turkey red" process (which originated in India) leaves very little to be desired in regard to permanence. The scarlet tint of Turkey red is pleasing, also, and its peculiar odor is easily recognizable, so that it has been a prime favorite for centuries.

Indigo, though it has been called "the king of dyes," cannot make out quite so strong a case. In very deep shades its tint is a dark, reddish blue, the warmth of which makes amends for its lack of purity and luminosity. These defects become conspicuous in lighter shades, which also give evidence that the insensitiveness to light, for which indigo is celebrated, is only relative, not absolute. Repeated washing also injures light shades of indigo, producing the faded tint so often seen in old aprons, shirts and overalls. But indigo is especially sensitive to chloride of lime, with which washerwomen, nowadays, are altogether too liberal. This soon bleaches indigo completely and irreparably and even affects Turkey red to a slight extent.

The superiority of alizarine to indigo in permanence is seen in old pieces of the favorite cross-stitch embroidery, done in indigo and Turkey red. The blue stitches are always found to have suffered more from use and washing than the red.

For black, logwood has long been held to be unrivaled. But on cotton, at least where permanence is required, it has been replaced by aniline blacks and the modern sulphur dyes. Here we have the first example of the superiority of an artificial to a natural dye used for the same purpose.

In the days of natural dyes no reliable or even moderately fast green on cotton existed. Hence green cottons are still unpopular, and justly so, for we do not yet possess a very permanent pure green, though synthesis has created in cerulein an olive-green cotton dye which is very fast, both to light and to washing—another instance of the superiority of an artificial dyestuff.

There are many permanent yellow dyes, both natural and artificial. With the aid of these a fast and fairly satisfactory green could be produced if we had a pure and permanent blue that could be combined with yellow. Yellow dyed over indigo gives a dull bottle green, thereby proving again that indigo is not a true blue, but a mixture of blue and black. Hence the Greeks named it Indian black (*melan indikon*).

But, notwithstanding his royal weaknesses, the king of dyes is true to his colors, as a king should be. Though faded and washed out, indigo-dyed fabrics are

still blue, while many otherwise good dyes become gray or blackened.

For dark shades indigo will always be valuable. For light shades a rival has lately appeared, an artificial dyestuff of such marvelous properties that no other dye, natural or artificial, can be compared with it.

This new dyestuff is indanthrene. Everything about it is unique—its preparation, the mode of its application and its relation to the fibers of cotton, for which alone it is adapted. Like alizarine, it is derived from anthracene. Indanthrene is the type of an entirely new group of dyes, the chemical structure of which has already been pretty exactly determined, and it has led to the discovery of other members of the group, including the yellow flavanthrene, the gray melanthrene and the deep blue cyananthrene. Indanthrene itself is made of various tints. The properties of all these dyes are very similar, and it is to be hoped that the family will increase, for the mode of application is so different from ordinary dyeing processes that mixing with other dyes is out of the question.

The indanthrene dyes give beautifully pure and luminous tints. Indanthrene itself produces on cotton a fine pure blue such as no other fast dye gives, while the unrivaled permanence of indanthrene is its most remarkable peculiarity.

It is less sensitive than any other dye to light, which practically does not affect it at all. Nor is it affected by ironing or rubbing—in contrast to indigo which, in dark shades, cracks or rubs off slightly. Indanthrene is absolutely unaffected by boiling soda and soap suds, and therefore it "washes" perfectly. Chloride of lime gives it a greenish tinge, but subsequent treatment with hydrosulphite solution restores the color to its original freshness. In indanthrene, therefore, we have a dye which, though it is not permanently injured by chlorine, faithfully reports the lapses of laundresses addicted to the chloride bottle. The purity of color of indanthrene enables it to give, with flavanthrene, a beautiful green, which is as fast as its components.

These properties of the latest products of the color industry justify its claim to have surpassed nature. Indanthrene is far superior to either indigo or alizarine, and though indigo may continue to rule the market as the king of dyes, its young rival has proved itself more worthy of the crown.

It might be supposed that a dyestuff of such almost ideal properties would be welcomed with enthusiasm by a public that is always complaining of the unreliability of dyes. But, although the indanthrene dyes have been on the market several years, there is little demand for goods dyed with them. This is due to the persistence of the prejudice that bright, pure tones, being produced by artificial dyestuffs, are necessarily fugitive.

The German and some other military authorities are wiser. Although they are cautious about adopting novelties, they are not bound hard and fast by prejudice. They soon became convinced of the extraordinary permanence of indanthrene, and the new dye has been adopted for the collars worn by German marines. Although it costs more than indigo, it might be adopted for all blue cotton goods with advantage, because of its durability.

The Japanese, who have given so many proofs of their intelligence, have also been wiser than we in this respect. They soon recognized the merits of indanthrene and objected only to the price of goods dyed with it. But some manufacturers and merchants got together, made a great variety of cotton goods dyed and printed with indanthrene, dubbed the new color ushiozume, "the color of the deep blue sea," and copyrighted the name. Then they put the fabrics on the market and exhibited them at the Osaka exposition. Soon all Japan knew of the excellence and durability of the ushiozume fabrics and a great demand for them arose. We may wait long for so desirable a consummation, unless it should occur to some enterprising merchant to import ushiozume goods dyed with German indanthrene and sell them at fancy prices as the latest Japanese novelty.—Abstracted from Prometheus.

LUNAR PHOTOGRAPHY.
By the Paris Correspondent of Scientific American.

The Paris Observatory was one of the first to take up the question of obtaining clear photographs of the moon's surface from which enlargements could be made and which would afford a great help to the study of lunar phenomena. For this purpose the great angle equatorial was constructed some years ago, and it is now constantly in use. Shortly after it was found that the instrument did all that was expected of it and furnished a series of very fine plates. Messrs. Loewy and Puiseux, the chief astronomers of the observatory, presented a memoir to the Academie des Sciences relating to lunar photography and the most modern methods which are now employed for this purpose, stating also the general lines upon which the atlas of the moon is being prepared at the observatory.

In the drawings of the moon's surface which have been made by hand and by different processes there is often much contradiction, as may be imagined, and the abundance of data seems only to increase the uncertainty. In order to carry on a systematic study of the moon's surface, and especially of the details, a series of photographic views of the proper size will be a desideratum which most astronomers will welcome, and our methods are now progressing so that we will soon be able to realize this. An objection to the first photographs, which were enlargements from the original plates, was that the smaller objects were lost to view, and it is these which are the most important and neces-

sary for discussing the history and the theory of the moon's formation. But recent improvements have brought the photographic method up to a much higher point of perfection. The greater sensitiveness of the films has allowed a shorter exposure and lessens the trouble which is due to the want of stability of the instrument and the lack of concordance with the moon's movement. Then a great step in advance has been made by Messrs. Paul and Prosper Henry in the way of constructing objectives which are achromatized specially for the chemical rays, besides the new methods of observation which were devised by them and which the observatory now makes use of in obtaining its charts of the stars which form the map of the heavens. Using the great equatorial, which has been installed some years and which is especially adapted for this work, along with the improvements in the method which we now have, we are able to execute a series of plates of the moon which show what can be done in this direction. Comparing them with the drawings executed by hand, we soon find out their superiority. At the time when the photographic method was not so far advanced, some astronomers, among others Dr. Weinek, of the Prague Observatory, considered that most of the details would be lost in the process of enlargement, and he undertook to make the enlargements by hand, using a wash of India ink which he brought to great perfection. But we are now able to affirm that photography is now in a position to rival with the hand method in distinctness, while it is far superior to it in accuracy, seeing that it is very difficult to render the details with fidelity and accuracy if we do not understand in advance the physical nature of these details, and in the case of the moon our knowledge is far from reaching this degree of progress. Besides, by comparing different photographic views which are made in the same evening we are able to detect all the slight errors of detail which may be due to imperfections in the gelatin. In our case, however, this has hardly been necessary, as in the enlargements we make, all the faults such as grains of dust or holes in the gelatin are shown generally with a sharpness of outline which distinguishes them at once from the variations in the surface of the moon, which are always graduated in outline. The photographic method is well adapted to realizing our desire of obtaining a complete atlas of the moon, which will show all the details of the surface and under different lightings. This problem has been taken up in a systematic manner at the Paris Observatory and the plates which are secured in the great telescope can be enlarged to a high degree. The method of enlargement also forms a special feature of the work. We soon found that this operation was as delicate and needed as many precautions as are used for the first part of the work, except that it does not depend upon the hour nor the weather. The examination and adjustment of the different parts of the enlarging apparatus, the choice of the source of light and the time of exposure need precautions which are to be compared with the most precise astronomical work, and it was found impossible to intrust this work to a simple operator.

In view of the results which we have already obtained, we consider it possible to realize the complete atlas of the moon with our instrument, without fearing an excessive expenditure of time or work.

In a second report which they presented to the Academy, Messrs. Loewy and Puiseux give an account of the progress which has been made in taking the photographs of the moon with the great equatorial. Referring specially to the enlargements which had been made from the plates which were exposed to the telescope, they state that the original images of the moon's disk measure about 7 inches in diameter. To be considered as quite satisfactory and to contribute to the complete work which has been proposed, to cover the entire surface of the moon, the plates should support an enlargement of ten or fifteen times. We are aware that it is not an easy matter to obtain such a result, even in the case of terrestrial objects where we can dispose of the lighting and the view point. Where we wish to reproduce the celestial bodies which are remote and always in movement, the difficulties are much increased. The execution of the images then exceeds the competence of ordinary workers and becomes a veritable scientific work. To bring this out it may be of value to take a glance at some of the difficulties which are to be overcome, as well as the favorable conditions we need to obtain.

The image of the moon, when observed under a rather high enlargement, seems to be always in a state of agitation. This circumstance does not prevent a practical eye from perceiving the small details, but it is fatal to the sharpness of the photographic impression. The image of two points whose angular distance scarcely exceeds the separating power of the objective will soon become confounded upon the plate, while still remaining distinct for the eye. There would thus be a great advantage in reducing the exposure to a small fraction of a second, if the plates we possess were sensitive enough. In practice, this is not possible, especially for the phases which are farthest from the full moon, which may need three seconds or more. Besides, the sensitiveness of the gelatin emulsion seems to vary inversely with the fineness of the grain, to some extent, and we must consider this latter quality to be quite essential, under the risk of having very poor enlargements. We are obliged to allow exposures of a certain duration, as long as chemistry has not furnished us with plates which are fine-grained and sensitive at the same time. Thus we must work as much as possible under the conditions which will avoid too long exposures. We will choose evenings when the temperature changes are small enough not to bring about air currents and abnormal refractions, and we will look out for instants when the atmosphere is quite calm and does not cause any appreciable vibration of the telescope. Special attention must be given to the time of exposure. This depends upon the presence of a slight haze before the moon, upon the phase which we wish to reproduce, the composition of the emulsion used, upon the age of the photographic plates. Uncertainty as to these different factors is a frequent cause of failure. But it is evident that in taking a great many plates under varied conditions we will sometimes obtain the desired coincidence of an exact time of exposure and a steady image.

Even if the image of the moon were entirely free from undulations, we cannot obtain a perfect result with an exposure of any great length, except where there is an exact concordance between the movement of the moon and that of the telescope. It is not easy to realize this accord, even for a duration of a few seconds. The horary variation of the right ascension is always great enough to demand a modification of the normal speed of the clockwork. This is carried out by M. Gautier's ingenious device which we have already described in our account of the telescope, and we are soon able to secure the accord between the two speeds. But the displacement of the moon does not only occur in right ascension, but is also shown in declination, either by reason of a variation in the geocentric polar distance or by the variable effect of the parallax. We may, by a judicious choice of circumstances of the observation, cause these two influences to work against each other and so to partly be neutralized. To this end we have calculated special tables which give at short intervals the effect of parallax in declination, but this necessity still further diminishes the number of days which are quite favorable. In case the exposure lasts several seconds we are able, by working the two hand movements of the telescope, to keep it constantly directed upon the same point of the moon. The small eyepiece which is disposed in the end of the telescope enables this to be done, by placing the cross wires upon a chosen star, but we find that on account of the weight and the distance of the main mirror the devices for making the declination movement have not the ease and precision which are needed to overcome all accidental variations, and after some experience we are obliged to use a different method which allows us to give small movements at will, in the two rectangular directions, to the system formed by the plate-holder and the supporting table. The mass which needs to be moved is thus very much reduced and we obtain greater sensitiveness. However, in this direction there was some improvement to be made. The clockwork movement, although it is brought to the mean speed of the moon, still showed some irregularities of short duration which could disturb the images which we secure with several seconds' exposure. However, we have succeeded in eliminating the errors due to this cause for the most part. While the series of photographs of the different phases of the moon is far from being complete, the plates which we have already obtained offer many interesting points of comparison with the previous work which has been done in this field. The lighting of the different parts of the disk, the tints, which are often very delicate and juxtaposed in the smooth regions, appear upon the plates with sharpness and a great variety of gradations. In this respect photography seems to have a great advantage over the eye, as the latter is soon fatigued by the excess of light. In the plates we find the smallest differences of level to be well defined. The mountains project clear and pointed shadows upon the plains, which are well adapted for making exact measurements. The abundance of details in the broken regions of the surface seems to surpass that of the best hand charts.

The representations of the moon which have been made heretofore are divided into two classes. The first seeks to reproduce exactly the aspect of a limited part of the moon under a given lighting, while the second class sums up a long series of researches in a graphic and conventional form. It is to the images of the first category that the photographic plates can alone be compared. These latter should be checked up and completed by others, and we could not consider that a single plate, no matter how perfect it was, makes later work on the same subject unnecessary, seeing that an object cannot be considered as well known unless we see it lighted on the east, the west, and on the side of the meridian. Thus the chart of the Circle of Maginus which is given in M. Nelson's work sums up more than twenty different drawings taken during five years of observation. It is, therefore, natural that a certain number of the reliefs of the surface which are shown here should remain for us plunged in darkness or but faintly visible on our plates. But the superiority of the photographic method becomes clear when we consider the truth of the general effect, and the intense expression of the relief. We may say that here the action of the powerful forces which have modeled the surface of the moon are taken in the act. It places a speaking and irrefutable document before the eyes of savants and their knowledge of geology and celestial physics enables them more surely to mount from the effects to the causes.

CANALS ON MARS.

EVER since the presence of canals or channels (canali) on the surface of the planet Mars was first described by the Italian astronomer, G. V. Schiaparelli, in 1877, the question of their character, and even of their real existence, has been keenly debated. On the one hand, they have been accepted as truly material formations, and various hypotheses have been advanced to explain them, such as that they are waterways connecting with oceans, or that they consist of lines of vegetation growing along irrigation works which derive their water from the seasonal melting of the polar snows and are the result of intelligent effort of some sort, or that they are merely great rifts produced in the globe by uneven contraction on cooling. On the other hand, some competent observers have failed to detect the canals at all, while others who have succeeded in seeing them have not agreed with each other in their descriptions of what they saw. In consequence it has been suggested that these canals or channels are of the nature of illusions of vision, and are not the definite features that appear on the drawings, but "rather the result of slight suggestions made to the eye by more or less irregular differences in the minute shadings and color tints on the surface of the planet."

Within the last few months fresh light has been thrown on the question by a piece of work carried out at the Lowell Observatory, at Flagstaff, Arizona. The observers there have always been among the most successful in seeing and drawing the canals; and they resolved to supplement their visual observations by an attempt to photograph them in the favorable conditions presented by the planet's opposition in the spring of this year, when it was comparatively near the earth. The observatory at Flagstaff enjoys exceptional advantages for such a task. It stands 7,250 feet above sea level, and therefore above many of the lower and denser layers of the atmosphere which incommode observatories at smaller altitudes, and it possesses the largest glass in the world mounted at such an elevation. Further the air is intensely dry, and its currents trouble the image less and produce less distortion and obliteration of detail than at lower levels in more humid conditions. Without such advantages the undertaking would be hopeless; even with them it was one of extraordinary difficulty and delicacy, and called for numberless precautions. It must be remembered that the diameter of the planet at the time was only some 15 seconds of arc, and that the view of it to be obtained even with the largest telescopes in favorable conditions is little, if any, better than that obtained of the moon with the naked eye. But to secure the required definition of detail it was usually thought necessary at Flagstaff to use only the central portion of the 24-inch object glass of the telescope, which accordingly was reduced by a diaphragm to an effective diameter of 12 inches; a color screen was employed that allowed only the yellow and orange rays to pass, and the extremely sensitive plates which had to be used permitted exposures of only from six to ten seconds, though during that time the utmost care had to be exercised to insure that the telescope followed the planet smoothly and exactly.

The result was that Mr. Lampland, Prof. Lowell's assistant at Flagstaff, succeeded in obtaining in May and June a number of photographs of the planet at different stages of rotation, which show canals quite distinctly and even present indications of the doubling which has been regarded as still more doubtful than the existence of the canals themselves. When a series of these photographs taken on the same night in close succession is examined the same markings are seen to be repeated from one to another, though naturally some of the pictures are better than others; and comparison of drawings made of the planet's surface by Prof. Lowell himself at about the same dates as, though quite independently of, the photographs show a close comparison between the two, canals having the same position and direction being perfectly visible on both drawings and photographs, even to the untrained observer. The defining power of the eye, however, is so much superior to that of the photographic plate that, although some 400 canals and 175 oases have been made out by Prof. Lowell himself, the photographs have so far revealed only about 40 canals and four or five oases. If it be admitted that the photographic plate cannot lie and can yield representations only of things that have a real objective existence, the conclusion to be drawn from the constancy of the markings on the successive photographs of a series and the correspondence between photographs of different series and almost contemporaneous drawings by Prof. Lowell would seem to be that the canals, whatever be their nature and origin, cannot be mere subjective illusions on the part of certain observers, but have an actual existence as material formations on the surface of Mars.—London Times.

THE PRESSURE OF LIGHT.*

WHEN a body rebounds from a surface it exerts an impulsive force on the surface, owing to the reversal of its momentum. If the body possesses a mass of m grammes and its velocity normal to the surface changes from $+v$ to $-v$ centimeters per second during the rebound, then the change of momentum is equal to $2\,mv$. If n bodies rebound from a square centimeter of the surface in one second, the pressure on the surface will be equal to $2\,nmv$ dynes per square centimeter. According to the corpuscular theory of light, a beam of light was supposed to consist of numerous particles possessing inertia, traveling with a definite velocity v. Consider a beam of one square centimeter sectional area, totally reflected normally at a plane surface; then if each particle possesses a mass, m, and there are n' particles in one centimeter length (or one cubic centimeter volume) of the incident beam, the number of particles reflected per second from a square

centimeter would be $n'v$, and the pressure exerted on the surface would be equal to $2n'v \cdot mv = 2n'mv^2$. But the kinetic energy per cubic centimeter of the incident beam is equal to $n'mv^2/2$, and that of the reflected beam has an equal value; therefore, the pressure produced would be equal to twice the total kinetic energy per unit volume in the space common to the incident and reflected beams. In 1876 Dr. S. Tolver Preston derived a similar result from arguments relating to the transmission of energy by belting. Maxwell proved that the same result holds according to the electromagnetic theory: the energy of the field is half kinetic and half potential, so that the pressure is equal to twice the energy per cubic centimeter of the incident beam, or the total energy per candle power in both incident and reflected beams. Lebedew, and later Nichols and Hull, have detected and measured the pressure due to light, and have found it to be in agreement with the results predicted by theory. Quite recently Prof. Poynting has found that when light is transmitted obliquely into glass, there is a tangential force exerted on the surface; this is due to the fact that the direction of motion of the tubes of force is changed on passing at an angle into an optically denser medium. It has generally been supposed that elastic solid waves, and pressural waves (such as constitute sound) exert no pressure on a surface on which they fall; but Prof. Poynting has found that, taking account of quantities of the second order of magnitude, which are neglected in the ordinary investigations, a pressure equal to the energy per unit volume of the wave train is also exerted in these cases.

THE ELECTRIC SPARK.

By Dr. G. A. HEMSALECH, of the Physical Laboratory of the Sorbonne, Paris.

THE name electric spark is given to the luminous and sonorous phenomenon which accompanies the sud-
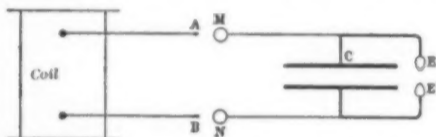
Fig. 1.—Condenser Charged by Induction Coil.

den and disruptive discharge of electricity through a gas. In the laboratory we distinguish two principal varieties of spark, according to the methods by which they are produced: the induction spark furnished by an induction coil and the spark caused by the discharge of a condenser, such as a Leyden jar, which has been charged by means of a static electrical machine or otherwise. In this article we shall consider only sparks

Fig. 2.—Electrode.

produced by the discharge of condensers through air at ordinary atmospheric pressure. The induction spark is a special case which is made very complex by the construction of the coil. Our knowledge of the nature of the induction spark has been greatly enriched in recent years by the researches of Walter, Klingelfuess and Sémenov. Klingelfuess, in particular, has succeeded in demonstrating in a striking manner, with the aid
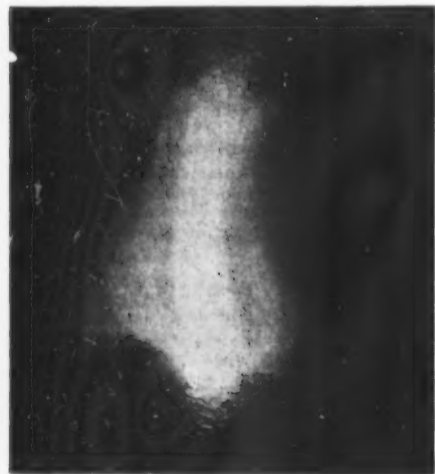
Fig. 3.—Ordinary Spark Produced by Discharge of Condenser.

of his powerful induction coils, the complexity of the induction spark.

Method of Producing Strong Electric Sparks.—In order to obtain long and strong sparks, such as we shall study in this article, it is necessary to be able to store up a certain quantity of electricity in a battery of Leyden jars or in a plate condenser. The latter pos-

sesses the advantage of facility in construction and manipulation.[*]

Such a condenser is usually charged by means of a static electrical machine, for example, a Wimshurst machine. For condensers of great capacity a larger machine is needed than is commonly found in physical laboratories, but, in default of a suitable machine, an induction coil giving a direct spark at least 20 centimeters in length may be employed. The method of
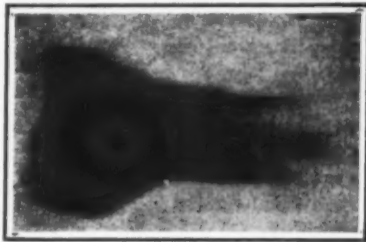
Fig. 4.—Aureola of the Ordinary Spark.

giving a static charge to a condenser by means of an induction coil is as follows: Instead of connecting the ends of the secondary coil (A and B, Fig. 1) directly to the coatings of the condenser, two gaps, $A M$ and $B N$, each about three centimeters in length, are made, one in each branch of the circuit. The discharge of the secondary coil, therefore, takes place through these spark gaps, the function of which is to prevent the condenser from discharging through the coil. Often a single gap will suffice and I have observed that a condenser can be charged from six to eight times as rapidly with a coil which gives sparks of 25 centimeters than with a Wimshurst machine with two plates.

In order to prevent too rapid loss of electricity charge by effluvium or silent discharge it is advisable to provide the terminals of the condenser, M and N, with balls about one centimeter in diameter. The terminals of the secondary wire of the coil, A and B, on the other hand, should end in fine points.
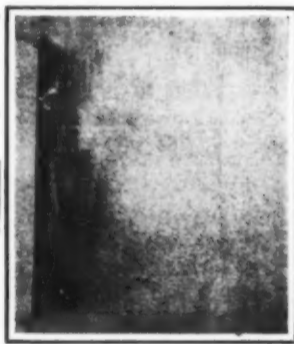
Fig. 5.—Oscillations in Aureola of Ordinary Spark.

The discharge of the condenser takes place through a second circuit, whose branches end in the metallic electrodes, $E E'$, which face each other across an air space in which the phenomena of the electric spark are produced. In general, electrodes in the form of balls are employed but in many cases it is preferable to give them the form of a cone with a smooth and rounded apex (Fig. 2). In our experiments we always use this form which makes the sparks more uniform and facilitates their observation. It goes without saying that the electrodes should be well insulated from each other.

Oscillatory Character of the Discharge.—Feddersen was the first to prove, by means of an ingenious experiment, that the spark produced by the discharge of a condenser is oscillatory, and thus to give a striking confirmation of the theoretical conclusions previously reached by Helmholtz and Lord Kelvin.

In his experiments Feddersen made use of a rotating mirror which projected the image of the spark upon a

Fig. 6.—Cadmium Spectrum Photographed on Moving Film.

plate of ground glass. The mirror was attached to an axis which could be rotated very rapidly and the same axis carried an arrangement which prevented the spark from passing except at the instant when its image was projected by the mirror in the direction of the ground glass. By giving a great rotary velocity to the mirror Feddersen was able to distinguish clearly the oscillations of the spark discharge and he could prolong the discharge by inserting an inductance coil in the circuit. In addition to the oscillating discharge Feddersen obtained two other varieties of discharge by increasing the resistance of the circuit, a comparatively small resistance causing a *continuous* spark, and a

[*] For details of construction and other useful information, see G. A. Hemsalech's "Récherches expérimentales sur les spectres d'étincelles," Paris, 1901. A. Hermann, publisher.

large resistance giving rise to an *intermittent* spark. These experiments of Feddersen have been repeated and confirmed many times.

General Appearance of an Electric Spark.—In a spark produced by the discharge of a condenser of great capacity two chief parts are easily distinguishable: a luminous line near the middle of the spark and an aureola surrounding that line. The brightness and the character of the spark depend, in the first place, on the resistance and the inductance of the circuit of discharge, but they depend, also, on the ma-
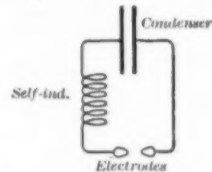
Fig. 7.—Condenser Discharging Through Inductance Coil.

terial and form of the electrodes, the sparking distance and the nature of the gas in which the spark occurs. As we have already said, we shall limit this paper to sparks in air at atmospheric pressure.

Classification of Sparks.—By taking account of the resistance and inductance of the circuit of discharge, we may distinguish four kinds of sparks: ordinary, oscillating, continuous and intermittent. An objection might be made to this classification because the ordinary spark is also oscillatory but, although this is the case, we shall see presently that there is a great difference between the ordinary spark and the spark which I call "oscillating," so that the distinction which I have made is justified. We will now examine the four classes of sparks in the order in which they are named above.

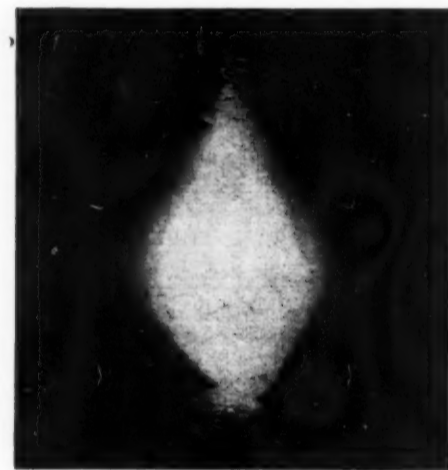*The Ordinary Spark.*—This is produced by the dis-

Fig. 8.—Oscillating Spark Between Aluminium Electrodes.

charge of a condenser when the resistance and the inductance of the circuit of discharge are very small. Fig. 3 shows a photograph of an ordinary spark, one centimeter in length, produced by the discharge of a plate condenser having a capacity of one-hundredth of a microfarad. Near the middle of this spark appears the luminous line, sharply defined and joining the ends of the two electrodes, which in this case were of aluminium. The aureola which surrounds the luminous line is very nebulous and irregular in form. It is composed, as we shall see, of metal torn from the electrodes and vaporized. Its size and brightness vary according to the nature of the metal of which the electrodes are

Fig. 9.—Oscillations Photographed on Moving Film.

Fig. 10.—Spectra of Nickel. Upper Spectrum Obtained with Ordinary Spark. Lower Spectrum Obtained With Oscillating Spark.

made. The explosive sound which accompanies the ordinary spark is comparable with that of a pistol shot. The duration of the spark is very brief. Wheatstone measured it with the rotating mirror and obtained values which varied from $1/1,000,000$ to $1/72,000$ of a second.

The spark being a luminous phenomenon we are able,

In investigating its character, to make use of the powerful methods of spectrum analysis. Thus, when we view a spark through a spectroscope we see a line spectrum composed of a great number of lines of various degrees of brightness distributed over the entire length of the spectrum. By examining successively sparks formed between electrodes of various metals it may be shown that certain lines remain unchanged for
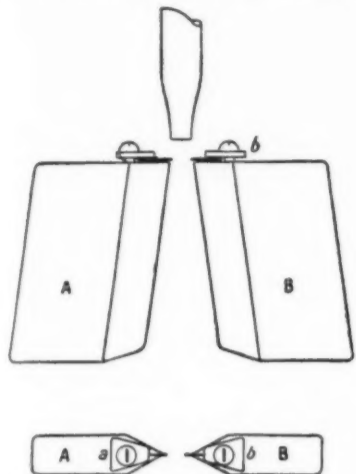

Fig. 11.—Deflagrator With Wedge-Shaped Electrodes.

all metals while others change with the metal employed. The former are due to the gas through which the spark passes, the latter to the metal vaporized by the discharge.

The spectrum of the electric spark, therefore, consists of two different spectra superposed. By Sir Norman Lockyer's method of projecting an image of the spark upon the slit of the spectroscope the different parts of the spark and the lines which they emit may be examined separately and successively. In this way it is found that the spectral lines of the gas, air in our
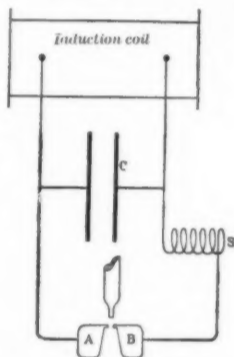
Fig. 12.—Arrangement of Apparatus for Discharge of Condenser by Means of Deflagrator.

case, occur only in the middle part of the spark along the luminous line, while the lines of the metal are found everywhere, even to the edge of the aureola. The metallic vapor, therefore, fills the space between the electrodes and forms the aureole.

What is going on in an electric spark during its brief existence? This is the problem which M. Schuster and I have endeavored to solve.

Experiments of Schuster and Hemsalech.[*]—In these experiments the image of the spark was thrown upon
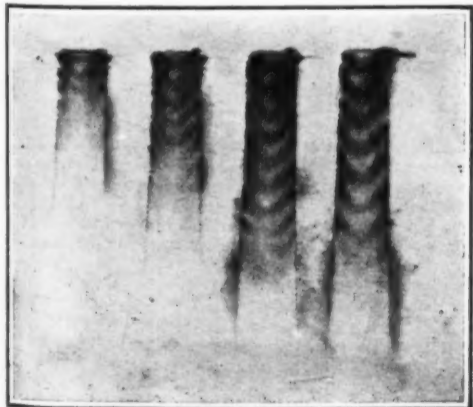
Fig. 13.—Effect of Capacity on Discharge.

a photographic film which moved very rapidly. The apparatus consisted of a steel disk 33 centimeters in diameter mounted on an axis which was driven by an electric motor. A circular photographic film, 30 centimeters in diameter, was applied to the disk and held firmly between it and a second disk, 22 centimeters in diameter, which was clamped concentrically on the

* For the details of these experiments see Philosophical Transactions of the Royal Society, vol. clxxxxiii., pp. 189–213. London, 1899.

first disk. The image of the spark fell on the annular strip of film which the small disk left uncovered. The electrodes were so placed that the spark was at right angles to the direction of motion of the part of the film which received its image.

Usually the disk made about 120 revolutions per second, which gave a linear velocity of about 100 meters per second for the part of the film which received the luminous pencil. In thus projecting on a moving film the image of a spark similar to the one shown in Fig. 3 we observed that the image of the luminous line remained motionless while the image of the aureola was considerably elongated, particularly about the middle of the spark. This proves that the luminosity of the bright central line is of very short duration but that the aureola remains visible for a comparatively long period. One of these photographs is represented in Fig. 4.* The bright line is not visible in the figure but it appears very clearly in the original negative where it sharply defines the left side of the image.

Fig. 14.—Simple Sheet Copper Electrode.

Fig. 15.—Intermittent Discharge.

This proves that the bright line is the first phase in the production of a spark and that it marks the path of the initial discharge. The oscillations, hidden by the aureola, are not visible in this photograph.

In order to show these oscillations we first projected the image of the spark on the slit of a collimator, the slit being parallel to the spark, and then threw the image of the slit on the photographic film, so that the image received by the latter was a fine and sharply-defined line. In this way the aureola was so greatly expanded and attenuated that it no longer prevented the oscillations from being resolved and seen separately. With this arrangement, indeed, we succeeded in photographing the oscillations very clearly. Fig. 5 shows an enlargement (five diameters) of a photograph obtained in this way. The frequency of the oscillations was one million per second. The straight line at the left of the figure is due to the initial dis-

* In Figs. 4, 5, 6 and 9 the direction of motion of the film is from right to left.

charge (the bright line). The series of curved lines correspond to the oscillations and on comparing Figs. 4 and 5, it becomes evident that these oscillations take place in the aureola. Their curvature indicates that the velocity of propagation of the oscillations is very much less than that of the initial discharge, which is

Fig. 17.—Effects of Foucault Currents.

represented by a straight line, notwithstanding the great speed of the photographic film.

For more detailed examination it was necessary to interpose a prism in the path of the luminous pencil and to project on the film the spectrum of the spark thus formed, in order to be able to distinguish between the rays emitted by glowing air and metal respectively. When the film was at rest, the lines of this spectrum were fine and straight but when the film moved very rapidly both straight and curved lines appeared in the spectrum. Fig. 6 represents the spectrum of cadmium obtained on a film which moved at the rate of 100 meters per second.

The examination of these photographs showed that the lines which remained straight were due to air and that those which became curved, when the film moved

Fig. 16.—Liquid Resistance.

rapidly, were due to the metal of the electrodes. Furthermore, the metal lines were broadened much more than the air lines. The metallic vapors, therefore, remain luminous longer than air and the particles of metal are projected from the electrodes with a measurable velocity. The broadening of the double line of nitrogen in the green corresponds to a duration of luminosity of only 4/10,000,000 of a second.

The inclination of the metal lines enabled us to calculate the speed of diffusion of the metallic vapor for each spectral line. Thus, for the aluminium lines we
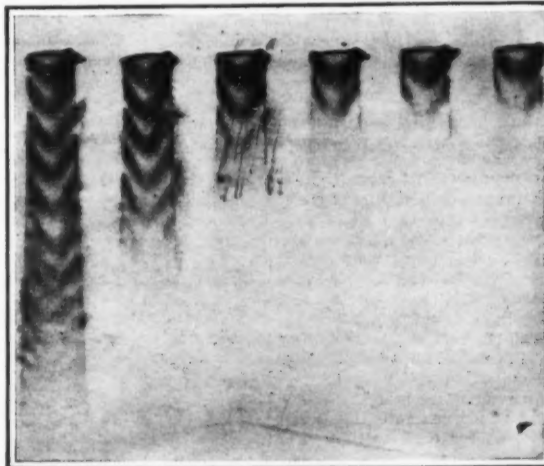

Fig. 18.—Effects of Hysteresis.

obtained a mean velocity of 1,890 meters per second. For the double cadmium line the velocity is 435 meters. Bismuth gave results of peculiar interest because some of its lines were greatly displaced (by the motion of the film), indicating very small velocities, while other lines were displaced very slightly, indicating very great velocities.

These experiments prove that the initial discharge gives the spectrum of the gas and that the oscillations

of the aureola give the spectrum of the metal. This result is confirmed by several photographs, in which the lines of the metals employed (bismuth and mercury) are repeated for each oscillation. The aureola, therefore, is composed of the material of the electrodes, which is carried off by the discharge and is heated and made luminous chiefly by the oscillations which follow the initial discharge. In short, an ordinary spark is formed in the following manner. First, the air between the two electrodes is pierced by the initial discharge and then the air in the immediate vicinity of the path taken by that discharge is heated to incandescence, forming the bright line. Immediately afterward, the space between the electrodes becomes filled with the metallic vapor which has been generated and carried away from the electrodes by the initial discharge,* and this vapor, which constitutes the aureola, is traversed and heated to incandescence by the oscillations which follow the initial discharge.

The Oscillating Spark.—When a condenser is allowed to discharge through an inductance coil (Fig. 7) the appearance and the sound of the spark are entirely changed. The bright line which was so conspicuous in the ordinary spark is now barely visible and the intolerable explosive noise has become almost agreeable. The form of the spark, also, has become more regular. Fig. 8 represents an oscillating spark, one centimeter in length, formed between electrodes of aluminium. The capacity of the condenser was 0.01 microfarad, and the inductance was 0.042 henry. The inductance coil was wound on a cardboard tube 50 centimeters long and 5 centimeters in diameter, and was composed of twelve layers, each containing 150 turns of well insulated copper wire. By using a coil of variable inductance it is found that, beginning with the ordinary spark, the form of the aureola becomes more regular as the inductance is increased, and that the bright line of the initial discharge becomes weaker until ultimately the spark appears to be formed entirely of incandescent metallic vapor. The shape assumed by the spark is spherical or ellipsoidal, according to its length. The form of the oscillating spark appears to be influenced, also, by the nature of the metal of the electrodes. Very regular forms are obtained with copper and aluminium, while cadmium and lead give oscillating sparks of somewhat irregular shape.

The brightness of the oscillating spark depends chiefly upon the nature of the electrodes. With electrodes of iron and cobalt the intensity of the spark at first diminishes, then increases as the inductance is increased, and attains a maximum for a certain value of the inductance.

With zinc, copper, cadmium, aluminium, lead, etc., similar variations in brightness occur but the maximum brightness is always less than with iron. The particular values of the inductance that correspond to the maxima and minima vary with the metal.

In photographing an oscillating spark on a moving film it is observed that the initial discharge has almost completely disappeared, while the oscillations which follow it are very strongly marked and, at the same time, slower and more numerous than in the ordinary spark. The photograph shown in Fig. 9 was obtained with the aid of a wheel, to the rim of which a photographic film was attached. As in the case of the ordinary spark, I employed a collimator and projected the image of the spark upon its slit. The speed of the film was only 15 meters per second. The capacity of the condenser was 0.014 microfarad and the inductance was 0.042 henry. The frequency of oscillation was 6,500 per second, and the total duration of the discharge was about 0.005 second.

On comparing this photograph with that of an ordinary spark shown in Fig. 9, it is seen that in the latter case the initial discharge is the main feature, while in the oscillating spark (Fig. 9) the oscillations predominate. Indeed, M. Schuster and I found that the spectral lines due to air and emitted by the "bright line" of the spark, which are always visible in the spectrum of the ordinary spark, are entirely absent from the spectrum of the oscillating spark, which is composed solely of metal lines of remarkable brightness.

The gradual evolution of these spectral lines can be traced by comparing Figs. 4, 5 and 9. In the absence of inductance the discharge is sudden and the greater part of its energy is expended in the initial discharge; with inductance the induced inverse currents prevent too rapid and sudden discharge, so that very little of the energy is expended in the initial discharge and the greater part of it is distributed among the oscillations.

The course of events in an oscillating spark is as follows: First, the air between the electrodes is pierced by a small initial discharge which incidentally generates a small quantity of metallic vapor. This vapor is then traversed by the first oscillation which heats it and also generates additional vapor. The second oscillation traverses and heats the vapor generated by the first, and the process is repeated for each oscillation of the discharge.

It is evident, therefore, that almost all of the energy is used up in heating the metallic vapor to incandescence. Only the small initial discharge is conducted by the air and this is not strong enough to heat the air to appreciable incandescence, though it is strong enough to generate metallic vapor, which is subsequently heated and made luminous by the oscillations which follow. With electrodes of copper, aluminium, and some other metals, however, the quantity of metallic vapor produced is so small that the oscillations

*This flux of metallic vapor is probably due, in part, also to the rarefaction of the air between the electrodes which is caused by the initial discharge.

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pass also through the air which has been made conductive by the initial discharge. In this case the bands of nitrogen appear in the spectrum. So, also, if a current of air is directed upon the oscillating spark, the initial discharge becomes more strongly marked and the spectral lines of air may appear.

Fig. 10 gives an idea of the difference between the spectra of the ordinary and the oscillating sparks. The figure represents a photograph of part of the spectrum of nickel. In the upper spectrum, which is that of an ordinary spark, the metal lines are more or less masked by the lines of air, while in the lower spectrum, obtained from an oscillating spark, the lines of nickel appear alone.

A New Method of Exhibiting the Oscillations of an Oscillating Spark.—The importance which electric oscillations possess at present, especially from the point of view of their application to wireless telegraphy and experiments with high frequencies, awakened the desire to make them directly visible. For this purpose several methods may be employed, notably that of the rotating mirror and photographic methods using moving films or plates, as well as the methods of the oscillograph and of the air current. But, as most of these methods are too complicated or costly for laboratories of modest equipment, I have devised an apparatus, quite simple and easily constructed, which shows the oscillations very clearly. The method is based on the well-known fact that the oscillations may be separated by blowing a current of air upon the electric spark. The apparatus includes a deflagrator of peculiar form. Two electrodes of copper, in the form of plates about 8 millimeters thick (A, B, Fig. 11), each having one edge shaped like a sharp wedge, are placed opposite to each other so that these edges are in the same plane and slightly inclined to each other. Upon the upper surface of each electrode, near the sharp edge, is clamped a small plate (a, b) which serves to hold in position a platinum wire. These wires, which play a very important part in our apparatus, project slightly over the sharp edges of the electrodes, A and B, and their ends are about 3 millimeters apart. The current of air is blown downward through the space between the electrodes from a glass tube which terminates in an orifice 3 millimeters in diameter, situated from 3 to 6 millimeters above the platinum wires. The electrodes are connected to the coatings of the condenser C, which are also connected directly (without any gap) to an induction coil capable of giving sparks at least 20 centimeters in length (Fig. 12). An inductance coil, S, without a metallic core, is included in the circuit of discharge. The current of air may be furnished by a cylinder of compressed air, or one of the cylinders of compressed carbonic acid, which are now found in commerce, may be substituted. In the absence of an air current the spark is formed between the two platinum wires and no oscillations are visible, but with a strong blast the spark is resolved into its various constituents. If the blast is constant the phenomena become very clear and steady and may be examined at leisure with a lens.

There is seen, in the first place, a fine, straight and brilliant line of light, joining the platinum wires. This represents the initial discharge. Below this straight line appears a series of broader bands which are curved, less bright and of a rose-purple color. These are the oscillations which are formed between the opposed edges of the electrodes. As many as sixteen oscillations may be obtained, but only the first six or ten are regular and motionless. Near the wires is seen a very bright cloud of platinum vapor. The surfaces of the wedge-shaped edges of the electrodes are furrowed here and there with sharply defined ramifications of intense violet light, which constitute the "negative envelope."

Fig. 13 is the reproduction of a photograph of a series of oscillating sparks obtained with the aid of this apparatus with (from left to right) one, two, three, and four condenser plates, each of 0.0008 microfarad capacity. The inductance, which remained constant for this series, was 0.042 henry; the velocity of the air current (computed from the total flow) was 36 meters per second; the time of exposure was half a second and the enlargement about 2½ diameters. The initial discharges appear at the top of the figure.

Spectroscopic examination shows that the initial discharges give the line spectrum of air while the oscillations give the band spectrum of nitrogen. In the conditions of this experiment the metallic vapor does not appear to participate in the conduction of the electric current.

The initial discharge which takes place between the platinum wires ionizes, or makes conductive, the air at that point. This ionized air is carried away by the blast and serves as a conducting bridge for the succeeding oscillations. The frequency of oscillation under the actual conditions of the experiment was 27,400 per second for the first spark (on the left) and 13,800 for the last spark (on the right). The flow of air was nearly 20 liters per minute.

It is absolutely necessary that the initial discharges of all of the successive sparks shall take place between the platinum wires. It is only under these conditions that the respective oscillations are accurately superposed so that the eye receives the impression of a continuous and fixed phenomenon. The number of sparks superposed per second is equal to the number of interruptions in the primary circuit of the induction coil.

The angle which the direction of the oscillations makes with that of the air current gives a means of measuring the velocity of the particles of nitrogen which carry the electric current. For a frequency of 27,400 oscillations per second this velocity is 29 meters per second. The velocity diminishes as the capacity

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of the condenser increases and it is directly proportional to the frequency of oscillation.

Satisfactory results can be obtained even with a much simpler apparatus. The electrodes are made of sheet copper, cut with shears into the form indicated in Fig. 14. The little point left projecting at one corner takes the place of the platinum wire of the more elaborate apparatus. The two sheets of copper are fixed with the points opposite each other and the rest of the apparatus is arranged as before. The copper points do not last very long so that the electrodes must be renewed frequently, but for a mere demonstration, in a lecture experiment, for example, this simplified apparatus is quite satisfactory.

Effect of an Inductance Coil with a Metallic Core Upon the Oscillations of an Oscillating Spark.—When an iron core is introduced into an inductance coil included in the circuit of discharge of a condenser the oscillations are destroyed to a greater or less extent, according to the material and structure of the core. For example, a thin iron tube destroys nearly all the oscillations without sensibly changing their frequency, while a core composed of iron wires insulated from each other diminishes the frequency of the oscillations without reducing their intensity so greatly. In the first case two influences are at work: the Foucault currents and the hysteresis of the iron, but in the second case the effect of the Foucault currents is almost suppressed. With the aid of our apparatus these effects may be exhibited very clearly. To show the effect of the Foucault currents we introduce gradually into the inductance coil a tube of sheet zinc, and observe a gradual increase of the frequency of oscillation to a maximum, which is attained when the sheet zinc completely lines the cardboard cylinder on which the coil is wound. We observe, also, that the number of oscillations in each discharge is not changed. Fig. 17 shows (from left to right) the effect of the gradual introduction of the zinc tube. The frequency of oscillation is 25,000 per second for the first spark (on the left) but it exceeds 50,000 for the last spark, when the tube has been completely inserted.

A zinc tube split lengthwise fails to produce the effects described above; the discontinuity of the tube prevents the circulation of Foucault currents. This fact may be utilized for the suppression of Foucault currents in the case of an iron core. Fig. 18 shows the effect of introducing gradually into the coil a split tube of iron. It is seen that most of the oscillations have been destroyed and that the frequency has been slightly diminished. To show that, with rapid oscillations, the effects of induction are due solely to the surface of the metallic core, the oscillations are first destroyed by means of the iron cylinder and then the zinc tube is slipped over this, so that it forms a screen between the iron and the coil. The oscillations at once make their reappearance, with increased frequency due to the Foucault currents.

It is now easy to understand the importance of winding on cardboard tubes inductance coils which are to be used in the production of electric sparks.

The Continuous Spark and the Intermittent Spark.—When the resistance of the circuit through which the condenser discharges is progressively increased, by the intercalation of a wet thread or a tube filled with acidulated water, the number of oscillations diminishes and the duration of the spark becomes longer. At a certain value of the resistance the oscillations disappear entirely and the discharge becomes continuous. The image of the spark in the rotating mirror is greatly elongated and appears like a long sheet of flame. When the resistance of the circuit reaches a certain higher value the discharge becomes intermittent, consisting of a series of feeble simple sparks which succeed each other at increasing intervals of time, as represented in Fig. 15.

At present we know scarcely anything about the nature and constitution of continuous and intermittent sparks. My own researches on these sparks have only begun and I cannot yet give any exact results. I can, however, give some useful hints of the method of exhibiting the peculiarities of these two varieties of sparks with the aid of the apparatus already described (Fig. 11). In the circuit of discharge of the condenser C (Fig. 12) the inductance coil S is replaced by a U-shaped glass tube (Fig. 16). The total length of this tube is 100 centimeters, its internal diameter about 7 millimeters. At each end of the tube an electrode of platinum wire, 2 or 3 centimeters in length, dips into the liquid which fills it. For the preparation of this liquid the following stock solutions are first made:

I. 5 grammes of H_2SO_4 in 100 grammes of water.

II. 2 drops (2/15 gramme) of solution I in 100 grammes of water.

For the production of the continuous spark 55 cubic centimeters or more of solution II. are diluted with 50 cubic centimeters of water. The current of air may be quite weak. The phenomenon is very distinct and the luminous arc completely fills the space between the electrodes (Fig. 11) from top to bottom. The intermittent spark is very difficult to produce but it can be obtained by patient experimenting. The following precautions must be taken: The angle between the edges of the electrodes must not be too large and the platinum wires must project only very slightly. The air blast should be very gentle and it is advisable to increase the distance between the mouth of the glass tube and the electrodes to 10 or 12 millimeters. The liquid resistance should consist of 20 cubic centimeters of solution II. diluted with 100 cubic centimeters of water. Distilled water should be employed in making all these solutions. The speed of the interrupter of the induction coil also influences the success of the experiment. When all the conditions are favorable a long series of

intermittences, preceded by an initial discharge between the platinum wires, is obtained.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Science au XXme Siècle.

CONTEMPORARY ELECTRICAL SCIENCE.*

RADIUM RAYS AND SPARK DISCHARGES.—G. A. Berti has collected some further material for elucidating the complex connection between radio-activity and discharge in a spark-gap. The latest experiments of Stefanini and Magri showed that for small spark-gaps the radium rays favor the discharge, while for large ones they impede it. At a certain middle value, the effect depends upon the shape of the terminals, the radium facilitating the discharge between a positive point and a negative disk, and impeding the discharge in the opposite direction. The author found that the limit of facilitating action was about 4 centimeters, and that the impeding action set in definitely at spark-gaps 12 centimeters wide. Even with the wide spark-gaps, however, there may be a facilitating action if the radium is far enough away, evidently owing to the filtering of the properly charged particles by the intervening air. This result was, however, obtained with an influence machine instead of an induction coil. The pole most strongly affected is the positive pole. The action is mostly due to the β-rays, for on deflecting these by a magnet most of the action, though not all, is stopped. The residue may be due to γ-rays. That it is not due to α-rays is proved by the fact that when the preparation is inclosed in a glass tube the effects are unchanged.—G. A. Berti, Nuovo Cimento, July, 1905.

ELECTROTHERAPEUTICS.—C. Renault summarizes the applications of undoubted utility nowadays made of electrical treatments, more especially in the case of workmen's accidents. He distinguishes direct applications, such as galvanization and faradization, and indirect applications, working by the generation of light, heat, or mechanical motion. Galvanization consists in the application of direct currents of about 12 or 15 milliamperes for some 15 minutes, the negative terminal being applied to the diseased part. This process is valuable in muscular atrophy occasioned by contusions, dislocations, or fractures, and in most diseases of the joints. The author has also found it efficacious in curing fistulæ occasioned by the careless handling of meat, using in this case a copper electrode inserted in the sore and reversing the current several times. Faradization is the treatment with alternating currents or with alternating currents superimposed upon continuous currents (galvano-faradization). It is employed both in muscular atrophy and in natural anæsthesia. Other applications are those of sinusoidal currents, high-frequency currents (auto-conduction), sparking and galvano-cautery. An interesting application is the electric stimulation of muscles for the detection of simulation, the reaction being quite independent of the will of the patient.—C. Renault, Archives d'Electricité Médicale, September 10, 1905.

REGENERATION OF FLUORESCENT SCREENS.—Barium platino-cyanide screens have a way of passing from a green color to a yellow and brown under the influence of prolonged exposure to X-rays and at the same time losing their fluorescence. Dr. Bordier has studied this process with a view of discovering a remedy. He finds that the change of color can also be produced by desiccating the screens by gentle heat, or by absorbing the moisture with sulphuric acid. It is already known that the screens recover on exposure to ordinary light, but the author shows that this recovery only takes place in the presence of moisture. The discoloration is, therefore, due to the loss of moisture, which is brought about by the X-rays through their ionizing action. Ammonium and potassium platino-cyanide show the same effects. The following process may be used to regenerate the screens: Break them up into small fragments and pour distilled water over them. The water extracts the salt, which crystallizes out in its original condition. This process applies to collodion screens, where the salt is shielded by a thick layer of collodion. When some other substance more permeable by water is used instead of collodion, the screens may be regenerated by a simple exposure to steam.—Bordier, Archives d'Electricité Médicale, August 24, 1905.

DISTINCTNESS OF TELEPHONE SOUNDS.—E. Wiersch makes some very pertinent observations on the conditions which determine distinctness in the reproduction of speech by the telephone, microphone, or phonograph. The sources of indistinctness are the sibilant sounds represented by s, z, sh and f. These are, as a rule, very imperfectly rendered or actually inaudible. The author found by manometric flame observations that the frequencies of these hissing consonants lie two or three octaves above the proper tone of the usual diaphragms. Now a diaphragm is most easily set in motion by a vibration of its own period. Notes of low pitch usually have some overtone which affects the diaphragm, but the hissing sounds are themselves too high for that. Their pitch is at least as high as that of a closed pipe 14 millimeters in length. To reproduce them faithfully, therefore, it is necessary to have membranes of high pitch, and these can be obtained by special tension devices and magnet construction. The various sibilants thus become clearly distinguishable. That the human ear can distinguish them the author explains by the fact that the external ear consists of a set of resonators responding to notes of very high pitch. Such notes are also produced by some insects, and by the bursting of froth bubbles.—E. Wiersch, Annalen der Physik, No. 10, 1905.

SCIENCE NOTES.

To a large extent the problems involved in a study of the assimilation of nitrogen are limited by the very imperfect chemical knowledge of nitrogenous products, and may not, therefore, be very clearly defined. Practically, the whole question of the formation of amides, proteids or other nitrogenous compounds in plants remains in obscurity. It is known that these are formed in both non-chlorophylous and chlorophylous plants and that while in the former it may proceed in darkness, in the latter light is apparently required for the most vigorous synthesis. In the latter case it may seem to suggest that there is need of the active co-operation of the chlorophyl apparatus; but here again the influence may be only indirect, since the roots, as well as the aerial parts of chlorophyl-bearing plants, are said to possess, to a certain extent, this synthetic power. Interesting suggestions have been recently made by Godlewski. The part played in photosynthesis by nucleus and cytoplasm, respectively, is unknown and may be important.

It is surprising that individual timber owners have done so little for themselves in matters of fire protection, especially in view of the fact that it is largely a local problem, and can be most satisfactorily dealt with as such. Adequate protection is undeniably a complex and difficult task. It is, however, no greater than many of the logging, milling, and transportation difficulties which have been successfully surmounted. It has been neglected merely because financial success has not been dependent upon it. The enterprise and ingenuity of American lumbermen is world renowned. For the cheap and rapid manufacture of lumber they have developed marvelous mechanical devices. But in matters of fire protection they are still little farther advanced than were the pioneers of the industry. Indeed, by opening up the forests and leaving large quantities of inflammable débris they have rather increased the fire danger. As it was fifty years ago, so it is to-day. No attention is paid to fires until they reach dangerous proportions; then they are fought with characteristic American energy; the mills are often shut down, all available men are employed to fight the flames, and the fire is usually controlled, but at great expense. The more rational and businesslike, and in the end the more economical method, systematic preventive measures and preparation for promptly extinguishing small fires, has seldom been employed.

Soon after the civil war great local interest was revived in the producing sections in the culture of castor beans. In some years the crop exceeded the consumptive demand; even the supplies required in the East were drawn from the Western States, and the import trade from British India was threatened with extinction. Statistics of production as a whole were not collected, and comprehensive knowledge of the crop is not obtainable. The few figures that are extant, however, are valuable, in that they constitute the only statistical record upon this subject. As to Missouri and Oklahoma, beyond the fact that the crop was raised on a commercial scale, little is known. But in Kansas, which was then the chief producer, the State board of agriculture reported an increase in the crop from 59,435 bushels in 1873 to 766,143 bushels in 1879, the latter being the highest annual yield that has ever been reported for the State. There is reason for believing that this bumper crop in Kansas constituted practically the entire crop of the country. The Illinois State reports show the crop of that State in 1879 to have been only 24,314 bushels; and that the crops of Missouri and Oklahoma were not of great importance is indicated by the receipts of castor beans in St. Louis, which in that year were only 516,507 bushels; the bulk of which was undoubtedly from Kansas. The effect of this increase in domestic production upon imports was that the latter, which as early as 1867 had amounted to 60,558 bushels, declined to 1,655 bushels in 1879. Although castor beans are not a perishable product and can be carried over from year to year, the effects of the heavy overproduction soon became apparent. Prices fell, and production rapidly declined until in 1884 it amounted in Kansas to only 89,183 bushels and to 19,295 bushels in Illinois. The import trade again became an important factor in the industry, the takings from British India attaining in that year the then unprecedented proportions of 262,505 bushels. Up to this date few important changes had occurred in the industry of manufacturing castor oil. At the taking of the census in 1870 six mills were reported. All the old mills, excepting one each in St. Louis and Jersey City, had passed out of existence; but, as a result of tentative efforts to introduce the cultivation of castor beans into Texas and Tennessee, three new mills had been erected in the former and one in the latter State. These four mills were of small capacity and short-lived; at the taking of the next census they had disappeared. The annual output of oil for the whole country, as reported by the census, was 341,850 gallons, of which 270,000 gallons was the product of the two principal mills. Eight mills were reported by the census of 1880, but the only noteworthy addition to the old-established branch of the industry was a new mill in St. Louis and one in East St. Louis. The other four were small affairs, located in Ohio, Illinois, and Kansas. A notable increase in the output of oil over that of 1870 was reported, the total quantity being 893,802 gallons, the increase being partly due to the enormous overproduction of castor beans in Kansas in 1879 and to the introduction of improved machinery into the principal mills. The next important addition to the industry was the Kansas City, Mo., mill, which began operations in 1885.

ELECTRICAL NOTES.

Since the introduction of the electric furnace, other new methods have been worked out for obtaining the higher temperatures. One of these is known as the thermit method, in which aluminium is the fuel consumed, the product of combustion being aluminium oxide, which is not volatile at the high temperatures, and therefore does not carry away the heat. By this means temperatures considerably exceeding 3,000 deg. can be readily attained. Calcium, magnesium, and certain other electropositive elements may be similarly utilized for attaining high temperatures, but the electric furnace stands alone as a means of producing these temperatures economically. The great advantage of electric heating is that it is not necessarily associated with products of combustion and does not need for its production a consumption of materials. In other words, it gives "pure, unadulterated heat." Therefore, for temperatures exceeding 2,000 deg. the electric furnace, if not the only means, is the most economical one to be employed.

The receiving apparatus of wireless telegraphy has undergone many modifications since the original filings coherer was invented. There is, for example, the single point contact, consisting of a pointed carbon lightly resting on a slightly oxidized steel surface; the Brown radioscope, consisting of a lead electrode resting lightly on a surface of peroxide of lead; the Lodge-Muirhead revolving disk, touching lightly on a mercury surface; the Schaffer so-called anti-coherer, consisting of a fine razor slit across a silvered glass surface; the Italian navy coherer, in which one or more globules of mercury are inclosed between carbon and steel contacts—all of which are dependent for their action on imperfect contacts; the bolometer and electrolytic methods claimed by different inventors; and finally, Marconi's electro-magnetic receiver. Many of these have been associated with variations in the original method of combining the different electrical elements of each circuit, and have been denominated "systems."

In a memoir presented to the Russian Physico-Chemical Society of St. Petersburg, C. D. Steinberg describes his researches upon a new phenomenon which he calls the thermo-electric discharge. Last summer, when observing the conductivity of the air caused by a hot body, he noticed an interesting phenomenon. Positive electricity is given off freely by a heated solid body and passes through the surrounding air, while on the contrary the air is non-conducting for negative charges of the same body. In his researches the author used the following arrangement. A spiral of platinum wire connected to the ball of an electroscope of the usual gold-leaf form, having been heated over an alcohol lamp, the latter was removed, after which the electroscope was given a positive charge. At first the electroscope leaves separate, then they fall quickly, in half a second or more, showing that the charge passes off from the heated spiral through the air. Repeating the test by giving a negative charge to the electroscope, the leaves remain apart and do not fall. If we place a second electroscope near the heated body, from 2 to 6 inches off, part of the positive charge of the first electroscope is sent to the latter through the air. This keeps up until the potentials of the hot and cold bodies become equal. In another experiment he brought a red-hot body near a negatively charged electroscope, the hot body being connected to earth, so as to produce a positive charge on this body by induction. At a distance of 4 to 8 inches the leaves commenced to fall and when at a distance of 1.2 to 2 inches, according to circumstances, the whole charge of the electroscope was annulled. When using a positively charged electroscope under the same conditions the latter did not undergo any variation.

Volcanic rocks sometimes contain some magnetized points and extensive areas of the same polarity, which according to recent researches are due to the effect of lightning. Inasmuch as the observations that led to this explanation were made at points struck by the lightning beforehand and where traces left by the latter were noted, Messrs. Gaetano and Giovanni Platania endeavored fully to elucidate the question by studying the same points both before and after they had been struck. As stated in a memoir recently presented to the French Academy of Sciences, they undertook some investigations on the magnetism of the rocks of Aetna volcano, ascertaining whether the blocks of basaltic lava which had been used in constructing the house of Messrs. Leonardi at Acireale were at all magnetic. They found, however, only an extremely feeble magnetic action, which could be ascertained only with difficulty. On September 20 last, some minutes before midnight, a violent thunderstorm resulted in the melting of a telephone wire, leaving the ground wire along the wall intact. The atmospheric discharge had doubtless traversed this ground wire. On the following morning the authors stated that the wall throughout the path of the wire showed a strong magnetization up to a distance of 13 centimeters, the north pole being situated at the left. The discharging current had thus been directed from underneath upward. During the same thunderstorm lightning struck the lightning arrester in the palace of Signor Fiorini, resulting in some damage. The conductors of this lightning arrester consisted of copper 8 millimeters in diameter and were held by porcelain insulators at 9 to 20 centimeters from the wall. This building is of recent construction and the lightning arrester had never been struck by lightning before. While the blocks of lava at some distance from the conductors did not show any appreciable magnetic properties, the action of the wall on the magnetic needle began to be felt at a distance

of 3 meters from the conductors. In the case of one of the latter the wall was found to possess, at the right and left, zones of contrary signs, being 15 to 20 centimeters in breadth. This magnetization likewise corresponded to a current directed upward. It is a striking fact that such intense magnetic effects should have been produced by an insulated wire so far distant from the wall.

TRADE NOTES AND FORMULÆ.

Improvement of Mantles.—According to German publications, mantles for illuminating purposes have been greatly improved during the past year or two, both with reference to the quality of the materials employed and the workmanship. Complaints are less frequent than previously. Still, it is difficult to increase the solidity and durability of mantles to a great extent without diminishing their illuminating power. Ramie, the vegetable fiber now approved, appears superior to cotton in many respects. Its use is spreading rapidly in Germany, as well as in England. Great progress has also been realized in machines for manufacturing mantles.

Adulteration and Fraud in Bone Powders and Superphosphates in Italy.—The Italian journal Il Coltivatore notices the frauds practised in that country in the preparation of bone superphosphates and bone powders. At times a quantity of nitrogenized organic matter is added to mineral superphosphates, such as powdered seed cakes or dust from turf, and the whole is sold as bone superphosphate. At other times genuine bone superphosphates are mixed with precipitated superphosphates, and the phosphoric acid is less soluble in water. As the cost of the phosphoric acid of mineral superphosphates is but two-thirds that of bone powder, preference is being given to the former, except for special purposes.

Protection of Acetylene Apparatus from Frost.—Alcohol, glycerine and calcium chloride have been recommended for the protection of acetylene generators from frost. The employment of calcium chloride, which must not be confounded with chloride of lime, appears preferable in all points of view. A solution of 20 kilogrammes of calcium chloride in 80 liters of water congeals only at 15 deg. below the Centigrade zero. But as this temperature does not generally penetrate the generators, it will answer to use 10 or 15 kilogrammes of the chloride for 100 liters of water, which will almost always be sufficient to avoid congelation. Care must be taken not to use sea salt or other alkaline or metallic salts, which deteriorate the metal of the apparatus.—Revue des Eclairages.

Calcium Carbide as a Mining Explosive.—The explosive force of acetylene in presence of a mixture of air and a body in ignition, says M. Marcel Yuédras in the Journal de l'Electrolyse, caused me to study the applicability of calcium carbide as an explosive of the same rank as dynamite or blasting powders. The explosion takes place in an air chamber, and the ignition is produced by electric priming. A special cartouch is charged with the carbide after it is granulated.

The charge is thus prepared: the cap is of sheet iron; on the bottom rests the charge of carbide, and above, separated by an insulating membrane, is the charge of water; then there is a cavity, where I place the electric priming. At the side of the cartouch is an iron percussion rod which is designed to break the membrane and give access to the water.

When the hole has been drilled, the loaded cartouch is introduced, then the wadding, and the orifice is closed with a wooden plug. The percussion rod is struck, and the acetylene liberated and mixed with the air (that in the air chamber and that remaining in the hole). Five minutes are allowed for the disengagement, and then the mine is fired by electricity. Contrary to what might be expected, there is no projection of rocks, but they are split up and easily removed by tools. The charge of carbide is 50 grammes, which sets free 15 liters of acetylene gas.

In view of my researches, the employment of calcium carbide as a war explosive may be considered feasible.

Process for Dyeing in Khaki Colors.—Bichromate of potash or of soda, chloride of manganese, and a solution of acetate of soda or formiate of soda (15 deg. Bé.) are dissolved successively in equal quantities.

The solution thus composed of these three salts is afterward diluted at will, according to the color desired, constituting a range from a dark brown to a light olive green shade. The proportions of the three salts may be increased or diminished, in order to obtain shades more or less bister.

Cotton freed from its impurities by the usual methods, then fulled as ordinarily, is immersed in the bath. After a period, varying according to the results desired, the cotton, threads, or fabrics of cotton, are washed thoroughly and plunged, still wet, into an alkaline solution, of which the concentration ought never to be less than 14 deg. Bé. This degree of concentration is necessary to take hold of the fiber when the cotton comes in contact with the alkaline bath, and by the contraction which takes place the oxides of chrome and of manganese remain fixed in the fibers.

This second operation is followed by washing in plenty of water, and then the cotton is dried in the open air. If the color is judged to be too pale, the threads or fabrics are immersed again in the initial bath, left the necessary time for obtaining the desired shade, and then washed, but without passing them through an alkaline bath. This process furnishes quite a series of khaki colors, solid to light, to fulling and to chlorine.—Translated from La Revue des Produits Chimiques.

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